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HYMENOPHYLLUM

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EIGHTY-NINE PLATES

To complete the family, my treatise on *Trichomanes* in the Old World[1] is now followed by a corresponding study of *Hymenophyllum.*

Trichomanes is a natural assemblage of fairly coördinate natural groups of species, having common characters which make the genus easily recognizable and definable. But these groups are almost all likewise clearly delimited, and are so easily recognizable and definable that only the fact that in a few details I was unable to make the job clean, clear, and finished, restrained me from treating these groups as genera, and my *Trichomanes* as a subfamily—as Presl and van den Bosch had done long before.

In contrast to *Trichomanes, Hymenophyllum* has seemed to be homogeneous, not composed of a considerable number of definable minor groups which could possibly be regarded as genera. Our ideas of the evolution of species almost compel the assumption that phyletic groups, independent after their origin, exist. I write "almost," because there is the possible alternative assumption that hybridization across the boundaries of such original groups has been general enough to produce a tangled or knotted skein instead of a divaricate system of phyletic lines. In this case "natural" and "polyphyletic," as applying to the groups, would cease to be antithetic terms. It is our custom,

[1] Philip. Journ. Sci. 51 (1933) 119–280, pls. 1–61.

right or wrong, to ignore this possibility. I will presently question the soundness of this practice.

There are of course in *Hymenophyllum* many groups of evidently related species. But nobody has hitherto been able to break the genus into such groups, with any confidence that they are natural, and to assign nearly every species to one or another of them. While this was the case, there was no such temptation as in the case of *Trichomanes* to raise even the recognizable groups to generic rank. Van den Bosch, criticizing Presl for setting up genera, appropriately quotes (Synopsis, p. 5 of reprint) Fries: "Vana sunt nova genera, sine universali specierum cognitione. ."

A number of the groups of species have been given names. Those first named and described as genera and including Oriental species are *Meringium, Leptocionium, Myrmecostylum,* and *Sphaerocionium,* all proposed by Presl in his Hymenophyllaceæ, in 1843.

Meringium was based on *M. Meyenianum* Presl, op. cit. 116, collected "at Manila" by Meyen, and doubtfully (and wrongly) included a second species, *H. blumeanum* Spr. The genus was ascribed to Trichomanoideæ, and *M. Meyenianum* was transferred to *Trichomanes* by van den Bosch. While little confidence can be placed in the accuracy of Presl's drawings, I am sure that this is the same plant described in the same work, page 140, as *Didymoglossum serrulatum,* and of late known as *Hymenophyllum serrulatum* (Presl) C. Chr. That it belongs in this group is manifest from the serrate margin and the form of the involucre. I identify it specifically by the form of the marginal teeth, the large, not very deeply cleft involucre with entire lips, and the fact that the species is common in the mountains of Rizal Province, the mountains nearest to Manila.

Leptocionium, ibid. 118, was founded on the Chilean *L. dicranotrichum,* with a doubtful second species, *L.? fucoides, Hymenophyllum fucoides* Sw. By its author it was distinguished from *Hymenophyllum* by its elongate, exserted receptacle. Incidentally, the margin was figured as ciliate and described as inciso-dentate with serrate teeth. The name has acquired importance because it was "emended in use" by van den Bosch and Hooker, and by more recent writers in general applied to a group, generic or subgeneric, eventually including all species with toothed margin, all those with entire margin being *"Euhymenophyllum."* These terms, as used, are absolutely untenable. Whatever the

size and rank of any group to be called *Euhymenophyllum,* it must include the type of the genus, which has a toothed margin. Both Presl and van den Bosch realized this, and neither used *Leptocionium* in a sense broad enough to include *H. tunbridgense.* Moreover, if the great group of Palæotropic ferns which have been called *Leptocionium* is held distinct from *Hymenophyllum* proper, the name of this group is *Meringium,* since this name antedates (by position) *Leptocionium,* and is typified by one of them.

Myrmecostylum, ibid. 119, based on *H. tortuosum,* similar to *Leptocionium,* is mentioned here because it is ascribed to New Zealand; it came really from the Antarctic American region.

Sphaerocionium, ibid. 125, with *H. hirsutum* Sw. as the species first enumerated, was set up as a large genus distinguished from *Hymenophyllum* by having the receptacle sterile at the base and enlarged at the apex, where it bears stalked sporangia. As proposed by Presl, it was not at all a natural group, but comprised species independently related to various minor natural groups left by Presl in *Hymenophyllum.* If, however, one were disposed to divide *Hymenophyllum* into two genera, distinguished by serrate and entire margins, *Sphaerocionium* would have to be the name of the great group with entire margin, of late known as *Euhymenophyllum;* in his third supplement, Christensen uses the term in this sense, for a subgenus. I adopt another alternative; to apply the term to a fairly well-defined smaller group. typified by its type species. This group, with ciliate margins and mostly stellate hairs, was recognized by Hooker in his Species Filicum, but has since rather lost recognition.

In the Addenda to his Epimeliae Botanicae (1849) 258, Presl proposed two additional genera:

1. *Mecodium,* with one species, *Hymenophyllum sanguinolentum* Sw., of New Zealand, without generic diagnosis other than that it is "analogous" in *Hymenophyllum* to *T. pallidum* in *Trichomanes.*

2. *Amphipterum,* with what is now called *H. fuscum* as its species, characterized by winglike outgrowths of the axes. This is a small, definable group, related to *Meringium,* but probably not nearly so to the American species with similar wings.

Van den Bosch, Versl. Akad. Wet. Amsterdam 11 (1861) 300, in an outline of his understanding of the proper classification of the family, proposed rather than established two additional genera: *Pachyloma,* typified by *H. marginatum;* and *Diploophyllum,* typified by *H. dilatatum.*

Hymenophyllum and *Trichomanes* are related. When they are well understood, if they are genera in a proper sense, it should be possible to recognize in each a relatively primitive element, most nearly related to the other. In *Trichomanes*, *T. pyxidiferum* can be selected with considerable justification as representing such a group. The corresponding group in *Hymenophyllum* should have an entire margin, and be without peculiar hairs. This fixes the primitive element far less precisely than in the case of *Trichomanes*. In the latter genus, the unspecialized group is characterized by filiform rhizome, absence of false veins, and absence of any kind of peculiarly thickened laminar cell walls, and the first two of these characterize the whole genus *Hymenophyllum*. Toothed margin, stellate pubescence, and supplementary wings on the rachis may be construed as features of specialization, marking the groups which uniformly display them as nonprimitive. Observing these principles, and noting its world-wide distribution as evidence of age, *H. polyanthos* might be regarded as representing the most primitive element in *Hymenophyllum*.

There is evidence subject to construction, and construed by Presl and in effect by van den Bosch, as marking a very different group of species as intermediate between *Trichomanes* and *Hymenophyllum*—those with partly tubular involucre and elongate receptacle.

Beside distinctions between the gametophytes and sporangia, which are not known for a sufficient number of species to establish their validity, the two genera have two general diagnostic differences: The involucre or indusium is cleft, deeply or to the bottom, in *Hymenophyllum*, consisting then of two "valves," while it is not thus cleft in *Trichomanes*. And the receptacle of *Hymenophyllum* is typically of definitely limited growth, and included by the involucre, while it is of comparatively unlimited growth, exceeding the involucre, in *Trichomanes*. Neither of these criteria is absolute. A species regarded as *Hymenophyllum* on other grounds, but with long, extruded receptacle, is on this ground easily suspected of affinity to *Trichomanes*. Likewise, a species of *Trichomanes* with the involucre cleft, however shallowly, is subject on this ground to the suspicion of affinity to *Hymenophyllum*. *Didymoglossum*, including *Taschneria*, has been regarded as an intermediate genus, on the latter ground. In this case, I dismiss the evidence as fallacious, believing that the bilabiate apex of the involucre is without genetic relation to the cleft involucre of *Hymenophyllum*.

There is, however, a considerable group of species, ascribed to *Hymenophyllum,* characterized both by elongate receptacles and by involucres cleft part-way down but not to the base—often not nearly so. This group includes *Meringium* and *Amphipterum* of Presl, regarded by him as intermediate genera.

That expression—intermediate—in Presl's time might express merely a combination of diagnostic characters. Today, if carefully used, it appraises this combination of characters as evidence of affinity. If the group seemed to be primitive in other respects, the features just mentioned would suffice to fix it quite positively as really related to *Trichomanes,* and therefore really intermediate. In fact, though, instead of being apparently primitive in other respects, it is the one group of species ascribed to *Hymenophyllum* that displays the greatest structural specialization. Because this is so, I am constrained to believe that the features of resemblance to *Trichomanes* are not due to mutual phylogenesis. While I postulate *H. polyanthos* as primitive in a monophyletic genus *Hymenophyllum,* I cannot also believe that a group with serrate margins and crested involucres—conspicuous features nowhere suggested by any sure species of *Trichomanes*—is more related to *Trichomanes* than are the many species with entire margins and crestless involucres.

The foregoing propositions, which are not true, or are hard to accept, all arise from the basic assumption that *Hymenophyllum* is a natural genus, a monophyletic group, homogeneous in comparison with *Trichomanes,* containing some primitive element ancestral to the rest of the genus. They have largely disappeared as problems, because I have come to the positive conclusion that *Hymenophyllum* is not a group of this kind. If there is a distinction in this respect, *Hymenophyllum* is even less homogeneous than *Trichomanes.* But the task of recognizing and identifying the natural groups collected in *Hymenophyllum* has proven incomparably more difficult than in *Trichomanes.*

As far as my work is concerned, this might well be because the groups in *Trichomanes* were largely recognized and defined by my predecessors; but this course of history may fairly be ascribed to the fact that the groups in *Trichomanes* are more easily recognized, and have therefore invited study. Mettenius, Prantl, and Giesenhagen, all studying intensively the anatomy of these plants, as a foundation for taxonomic work at which they never arrived, devoted much attention to species of *Tricho-*

manes and comparatively little to those of *Hymenophyllum*. Van den Bosch alone undertook a careful study of the known species of *Hymenophyllum*. He died just when his data were ready to serve for the proper grouping of the species; and the study of the voluminous notes in his herbarium has been a wonderful object lesson as to the amount of information that can be assembled, and then lost. Even the data published in the two supplements to his Synopsis have been completely overlooked by later writers, although they are far more comprehensive than the collective work of the three to whom I have just referred.

Substantial conditions which have prevented or made difficult the recognition of the natural groups within *Hymenophyllum*, as I see these conditions and these groups today, are—

1. The absence of single conspicuous criteria for the recognition of such groups. *Trichomanes* is really remarkable for such convenient criteria—the false veinlets of *Taschneria*, the marginal strand of *Crepidium*, the frond form of *Cephalomanes*, the cell structure and cell arrangement of *Abrodictyon*. Except for single species like *H. Malingii* and *H. odontophyllum*, which have no effect on the problem as a whole, and except for the stellate hairs of *Sphaerocionium*, such convenient and infallible criteria are wanting in *Hymenophyllum*. Any unknown *Trichomanes*, of unknown origin and sterile, can be assigned positively to its group. With my present knowledge, at any rate, this is far from true of *Hymenophyllum*.

2. To recognize the groups of *Hymenophyllum*, we have to some extent to use characters of degree, or characters dependent upon complete maturity. With the exception of *Sphaerocionium* all larger groups in *Hymenophyllum* depend for recognition upon characters of the sorus; and the extent to which the involucre is cleft and the length of the receptacle (if it is slender) are matters of degree.

3. The major groups within *Hymenophyllum* have to be recognized by combinations of characters. The groups in *Trichomanes* have of course combinations of characters, but can mostly be recognized by single ones; and where combinations are required, as to distinguish between the groups of *T. radicans* and *T. apiifolium*, which are alike in absolutely simple laminar structure, the diagnostic difference (elongate rhizome or erect caudex) is so obvious as to be used almost unconsciously.

4. Most confusing, the group criteria in *Hymenophyllum* are not infallible. By far the most familiar of these is the mar-

gin, as toothed or entire. I am perfectly sure that *H. macroglossum, H. Lobbii,* and *H. penangianum,* with entire margins, belong in a group characterized by marginal teeth. I believe that *H. Reinwardtii, H. thuidium,* and *H. samoense,* with serrulate margins, belong in a group otherwise without teeth. And there are several pairs of species—*H. Deplanchei* and *H. Baileyanum, H. macrocarpum* and another plant on the same mountain doubtfully referable to *H. polyanthos*—one toothed, the other entire, which are so alike that it is hardly possible to question their affinity.

5. Complication of the evolutionary "tree" by ancestral hybridization. I have already noted that this possibility is usually ignored, and that I cannot continue to ignore it. Conclusive proof of ancestral hybridization is in the nature of the case very difficult. I am not entirely convinced that it has happened between the major groups in *Hymenophyllum,* although it offers the simplest explanation of the occurrence of pairs of similar species not referred to the same group.

But there are some phenomena which seem to me to be explicable in no other manner, namely:

1. The occurrence in the New Zealand area, and nowhere else, of species with the lamina wholly or partly more than one cell thick—*H. dilatatum, H. demissum, H. australe.* Except in this one respect, these species do not seem very nearly related. This phenomenon is so remarkable in this family that it led van den Bosch to establish a subfamily to include these species; but in other respects they seem so clearly to belong in separate minor groups that even his proposed genus, *Diploophyllum,* is untenable. This one character looks like a common inheritance. With all other characters testifying to distinct ancestry, the apparent explanation is that this one character was planted in several minor groups by hybridization. It may be postulated that the remote enough ancestors of the whole family had leaves structurally like those of other ferns, and that the plural layers of these species are vestigial. Why then is the phenomenon restricted in area? And is it mere coincidence that *Cardiophyllum* is endemic in the same area?

2. Many New Zealand species have in common a peculiar odor, evidently responsible for the name of *H. sanguinolentum,* although to my sense of smell it is not that of blood. In some cases these species are related as judged by other characters; in other cases they seem to belong in quite distinct groups. The relatives of *H. rarum* in the South African region retain

this odor. The same explanation, hybridization in the past, will apply to the presence of this odor in species of different minor groups; and the alternative explanation, that it is a vestigial character, can hardly be invoked in this case.

While *H. dilatatum, H. demissum, H. multifidum,* and *H. australe* have been supposed to range across the Malay region, New Zealand seemed, as far as the evidence of this genus went, to be a part of that great region. I find now that all of these are local species, not even very nearly related to the Malayan ferns which have been confused with them; and doubt if any one of the many New Zealand species ranges as far as the New Hebrides, New Caledonia, or Samoa. In an altogether local flora, a character implanted by hybridization, in a group where it is otherwise foreign, may be supposed to have a far better chance to persist, than it would have where it is more exposed to the swamping-out influence of a greater, more diverse, more competitive flora.

3. There is, however, a fairly evident case of the same kind in the richest of all fern floras: the presence in New Guinea of a considerable number of species with dark, opaque, rather coriaceous fronds—*H. opacum, H. ovatum, H. firmum,* and *H. geluense.* There are others, but these four are cited because, with this conspicuous textural character in common, they seem otherwise to belong in four very distinct groups or subgroups. I can imagine no local peculiarity of climate or soil able to produce this result by parallel or convergent evolution, and therefore turn again to hybridization between groups and subgroups as the only acceptable explanation.

We describe, classify, and identify plants by means of their "characters." In practice, the characters used are morphological, as preserved in the herbarium. The usefulness of a character in taxonomy and identification depends primarily upon its constancy; as one character may be variable from individual to individual and thus, within the range of variation, be useless in the description or identification of the species; another may be constant for the species and serve for specific characterization; while others are constant for groups of various sizes and ranks, and serve as group characters. As a secondary consideration, the usefulness of a character depends upon its ease of perception.

Since the utility of a character depends upon its constancy, and the constancy can be appraised only by the comparison of many specimens, it is obvious that the more ample the material

subjected to careful study (up to the indefinite amount necessary for safe, final judgment), the sounder will be the conclusions as to the species and other groups. As I have been able to study several times as much material as van den Bosch, and many times as much as any other student of *Hymenophyllum* seems to have used, my conclusions have a correspondingly greater probability of correctness. Still, like all who have gone before, I have described new species from a single collection, which in itself affords little opportunity to appraise the validity of its specific characters.

There is always some measure of insecurity in assuming the value of any character for purposes of diagnostic description. It is particularly unsafe to assume that because a character is useful for these purposes with one species or in one group, it has the same value in other cases. I do not know that any character is always equally serviceable, and suppose that none is so. As an ideal procedure, every character should be tested every time it is used. No standards of thoroughness demand this in the study of a flora still in considerable part unknown. I have tested some of the characters used in this study, for the identification of some species, with considerable thoroughness, and have been surprised by their lack of constancy. Thus, *H. formosum* has been credited with a certain very characteristic form of receptacle, but I find this structure varying far from its description, even in the type collection. The same study which led to this observation showed, though, that it varies within limits; that this species (which will be called *H. imbricatum*) is perfectly distinct in this character from its common and similar neighbor, *H. emarginatum*, and practically so from its nearer relatives, *H. Junghuhnii* and *H. badium*. Because the examination of many hundreds of sori of these species has taught us the limits of common variation, we have been able, by examining one sorus of the type of *H. emarginatum* to determine positively which of several species, bearing other and later names, ought to bear that name.

With the same thoroughness we have tested the form of the involucre of *H. polyanthos*, and the presence of toothlike infoldings of parts of its marginal walls. So also the structure of the walls of several species. More careful study has repeatedly shown that what looked at first like good specific characters, and what have been so accepted, are inconstant, not merely from place to place or from plant to plant, but even on different parts of single fronds.

Outgrowths of peculiar patterns—ribs, crests, teeth—on the tube of the involucre, beautifully illustrated in Hymenophyllaceae Javanicae, have been regarded as exact diagnostic characters of the several species producing them. We have found these structures far from constant, varying in size and distribution, to a certain extent interchangeable, and possibly absent in certain places (the ventral face of the tube); but that after our examination of almost innumerable sori we can still use them, and more safely, for specific recognition; and that now they serve also for the detection of relationships, as the Philippine *H. serrulatum* is found to be most nearly related, among Javan species, to *H. holochilum.* But just such crests and teeth have no diagnostic value at all in the case of *H. sanguinolentum,* and I describe *H. gorgoneum,* as characterized by them, without enough material for any appraisal of their constancy in its case. The next writer may have to treat it as I treat *H. cristulatum.*

I abstain from a further discussion of the value of the individual characters at this point, because it has to be taken up in many individual cases in the course of this treatise.

Returning to the subject of the phylogeny of *Hymenophyllum,* and of the phyletic groups into which I try to break it up, the proposed groups are as follows:

Phyletic group.	Species.	Typified by—
1. *Meringium*	Many	*M. Meyenianum* Presl.
2. *Amphipterum*	4	*H. fuscum* Blume.
3. *Myriodon*	1	*H. odontophyllum* Copel.
4. *Hemicyatheon*	2	*H. baileyanum* Domin.
5. *Euhymenophyllum*	Many	*H. tunbridgense* (L.) Smith.
6. *Mecodium*	Many	*H. polyanthos* Sw.
7. *Craspedophyllum*	1	*H. marginatum* H. and G.
8. *Sphaerocionium*	Many	*H. hirsutum* Sw.
9. *Apteropteris*	1	*H. Malingii* Hooker.

Postponing a fuller discussion of each of these to its individual presentation, I will note here, for purposes of general introduction, that *Amphipterum* and *Myriodon* are local derivatives of *Meringium;* that *Craspedophyllum* is likewise local, and probably derived from *Mecodium;* that *Apteropteris* is a local relative of *Sphaerocionium;* and that all four of these groups are maintained because their separate recognition gives no more than proper emphasis to their respective remarkable peculiarities, and their removal from the larger groups leaves the latter

easier to define. In a discussion of *Hymenophyllum* as a whole, they require no further mention.

Meringium has one African species and ranges thence to Polynesia. I have not yet tried to determine whether the American species that have been called *Leptocionium* are *Meringium*, or *Euhymenophyllum*, or both, or neither. *Euhymenophyllum*, *Mecodium*, and *Sphaerocionium* are cosmopolitan, as that word is understood in dealing with this family.

Meringium is like *Trichomanes*, and unlike *Hymenophyllum*, as usually defined, in its long-exserted receptacle. In this respect, and also in the cell walls of many species, it is particularly like the group of *T. rigidum*, which I have regarded as far from primitive. The tubular lower half of the involucre is also suggestive of *Trichomanes*, but I mistrust this character as evidence of common inheritance.

Boschia is like that group of *Trichomanes* which has seemed to me most primitive—that of *T. pyxidiferum* and *T. radicans*, in its complete lack of structural differentiation (in the lamina). It is impossible for me to believe that *Mecodium* is descended from *Meringium* or *Meringium* from *Mecodium*. While both may be recognized as related to *Trichomanes*, they are independently so related.

Euhymenophyllum is, in its diagnostic characters, intermediate between *Meringium* and *Mecodium*. In my opinion, this is not because either of these is related through it to the other. Its discontinuous distribution suggests that it is very old. It is conceivable that it is ancestral to *Meringium*. To test this possibility, let us assume that some element in *Trichomanes* is the ancestor of *Hymenophyllum*. Then, in the evolution of *Meringium*, the receptacle was first shortened and then restored, and the tube of the involucre was cleft and then largely restored. Without evidence—and there is none—we do not adopt such hypotheses. Of course, it is a mere assumption that *Trichomanes* is the ancestor of *Hymenophyllum*. But, if we would picture the usual type of genealogical tree for all of these groups, some group must be placed in the position of the most primitive; and whatever group is placed there, difficulty of the kind just presented will ensue. *Trichomanes* has to be considered in any such attempt. If this were not so, it would require a relatively slight strain of the imagination to regard *H. polyanthos*, or *H. peltatum*, or something like *H. edentulum* as primitive, and the whole of *Meringium, Euhymenophyllum*, and *Mecodium* as derived therefrom. As it is, these three

groups impress me as coördinate, unquestionably related, but with a common ancestry which I neither know nor picture.

Somewhat different data enter into a discussion of *Sphaerocionium,* but a discussion of them along the lines just followed would lead to the same conclusion—that this is a fourth coördinate group. There is one point of particular interest in *Sphaerocionium;* namely, that it is probable ancestor to a group of species, *"Microtrichomanes,"* with so much superficial resemblance to *Trichomanes* that most of them have been placed there without the mention of a doubt. After describing *Trichomanes Lyalli* (Trichomanes 163), I commented: "This is not merely congeneric with *Hymenophyllum obtusum;* it is hardly more than a reduced form of that species, which, in small but still fertile forms, becomes more flabellate than pinnate. I am not questioning the generic position of *H. obtusum,* nor the affinity of *T. Lyallii* and *T. palmatifidum;* but am leaving *Microtrichomanes* in *Trichomanes,* until the question of generic boundaries may be studied as a whole."

The species in question is a *Sphaerocionium, Hymenophyllum Lyallii* Hooker, correctly placed when discovered. *Trichomanes palmatifidum* and *T. Ridleyi* are also species of *Hymenophyllum,* in the broad and usual sense. We encounter here again the phenomenon of the loss of common distinguishing criteria in the course of the simplification inevitable with much reduction in size. However similar the little flabellate representatives of the two genera may be—and the likeness goes so far that I would not think of separating them generically without knowing their generically distinct relatives (ancestry)—this resemblance is not proof or, once the case is understood, even evidence of affinity. *Hymenophyllum* and *Trichomanes* converge here; they have not diverged from a common ancestry represented by their simplified species.

The foregoing argument shows that I agree with my predecessors in the study of this family—Presl, van den Bosch, and Prantl—that the customary assignment of all species to two genera cannot be justified. However, because the fixing of the tenable genera will best be done for the entire family at one time, and because I desire this treatise, as a matter of convenient use, to be a companion to my Trichomanes, I reserve the presentation of the genera, as such, for later publication.

As material for this study, I have had my own herbarium, the Philippine National Herbarium, and on loan the appropriate collections from the University of California, the United States National Herbarium, the Gray Herbarium, the Queensland Herbarium, and, preëminently important in this family, the Rijks Herbarium, Leyden. The last contains the specimens, manuscripts, and drawings of van den Bosch, published and unpublished. To the directors and curators of these herbaria, and particularly to Doctor Lam, I would express better than I can my sense of obligation and gratitude. For assistance with particular plants, I take pleasure in acknowledging the courtesy of Doctor Christensen in sending me the type material of his *H. carduncululs* and of several Madagascar species; of the Berlin Herbarium in sending type material of *H. Rosenstockii* and *H. herterianum;* of Mr. Holttum in lending the type of his *H. johorense;* and of the Stockholm Herbarium in permitting me to examine a fragment of the type of *H. emarginatum.*

I have also gratefully to acknowledge assistance in the compilation of the literature by Dr. E. Quisumbing and by the library staff of the Bureau of Science; by Dr. H. L. Maxon in making copies of descriptions and in the loan of books which I had secured at the University of California while working on *Trichomanes;* and particularly by Doctor Maxon, who provided me copies of particularly inaccessible descriptions, even such as were not in Washington.

With all this assistance, I have been able to utilize the older literature, and have been able to secure dependably authentic material of nearly all of the older species. The only considerable gaps are some rare New Zealand species, and a considerable number described in Java. As I approach the end of the work, the Third Supplement to Christensen's Index brings to attention several omissions.

The drawings are by Messrs. L. Alicbusan and E. Borbe. If the quality of their work is preserved in reproduction, any verbal praise of it is superfluous. Both came to me trained in science (professionally, Alicbusan is a plant pathologist), skilled in technical manipulation, and able to see with scientists' eyes. They have helped me, therefore, otherwise than as artists, verifying, for example, the constancy of structural peculiarities by examining long series of specimens.

Key to the subgenera of Hymenophyllum.

Stellate hairs absent.
  Receptacle indefinitely long, involucre with conspicuous tube.
    Tube obconic.
      Axes winged only in the plane of the frond. 1. *Meringium.*
      Axes bearing accessory wings.......... 2. *Amphipterum.*
      Lamina consisting wholly of teeth.......... 3. *Myriodon.*
    Tube cup-shaped .... 4. *Hemicyatheon.*
  Receptacle included or nearly so, involucre deeply cleft.
    Margin toothed with sharp teeth.......... 5. *Euhymenophyllum.* p. 97
    Margin entire or obscurely toothed.
      Fronds without differentiated margin.......... 6. *Mecodium.* p. 93
      Fronds with black marginal strand.......... 7. *Craspedophyllum.*
Stellate hairs present.
  Lamina present .... 8. *Sphaerocionium.*
  Lamina wanting .... 9. *Apteropteris.*

1. Subgenus MERINGIUM (Presl)

Meringium PRESL, Hymen. (1843) 116, as genus.

Involucre consisting of a distinct and well-developed tube and two large lips; receptacle slender, indefinite in length, the sporangia developing successively from the top downward, their wall cells numerous; fronds pinnate in plan, the axes (minor or all) bearing on each side a wing, one cell thick. The margin is almost always serrate, and never ciliate; the axes are usually hairy beneath; the internal cell walls are usually considerably thickened, the pattern of the thickening being in general characteristic of groups of species; without false veins.

The largest and most difficult Palæotropic group in the family. From it are derived *Amphipterum,* with accessory laminar wings, and *Myriodon,* with the lamina composed of many discrete teeth with bases elongate along the axes. With these two derived groups, *Meringium* is distinguished from all others in the family by the form of the involucre. *Didymoglossum* and *Taschneria* do, indeed, have a tube and two lips, but the lips are small, more like appendages of the tube than coördinate parts of the involucre. The indefinite receptacle is like that of *Trichomanes,* but stouter than in most trichomanoid groups. There is some resemblance between *Meringium* and the group of *Trichomanes rigidum,* in structure as well as in the receptacle.

Key to the species of the subgenus Meringium.

Margin entire.
  Axes decidedly hairy.
    Frond linear-elliptic, symmetrical. (Basilan.).... 6. *H. pulchrum.*
    Frond flabellate to lanceolate. (Malaya.).. 5. *H. pachydermicum.*

Axes naked or slightly hairy.
    Walls regularly very thick, coarsely pitted.
        Rachis winged throughout. (Ceylon.) .... 3. *H. macroglossum.*
        Rachis terete at base. (Malaya.) .... 4. *H. penangianum.*
    Walls irregularly thickened.
        Frond plane. (East African islands.) .... 1. *H. ricciaefolium.*
        Frond somewhat crisped. (Madagascar.) 2. *H. pollenianum.*
Margin subentire. (Assam; Borneo?) .... 7. *H. edentulum.*
Margin toothed.
    Frond normally 3 cm long or longer.
        Rachis terete at base.
            Lip of involucre entire or nearly so.
                Frond distinctly red. (New Guinea.) .... 33. *H. rubellum.*
                Frond black. (New Guinea.) .... 34. *H. firmum.*
                Frond green to brown or reddish brown.
                    Tube without prominent projections.
                        Internal walls uniformly thin. Tube, at most, marginate.
                            Fertile segments short. (New Zealand.) 43. *H. multifidum.*
                            Fertile segments normal. (New Zealand.) .... 44. *H. bivalve.*
                        Internal walls thickened.
                            Frond deltoid, long-stipitate. (Africa.) 45. *H. triangulare.*
                                Axes hairy beneath.
                                    Marginal teeth many, sharp. (Luzon.) .... 14. *H. bontocense.*
                                    Marginal teeth few, obscure. (Fiji.) .... 37. *H. Macgillivrayi.*
                                Frond glabrous. (New Caledonia.) 35. *H. viride.*
                            Frond lanceolate to ovate.
                                Frond up to 5 cm long.
                                    Frond compact. (Negros.) 13. *H. campanulatum.*
                                    Frond lax. (Luzon.) 12. *H. bicolanum.*
                                Frond normally larger.
                                    Superficial walls reticulate. (Luzon.) .... 11. *H. vittatum.*
                                    Superficial walls not pitted.
                                        Rachis slightly hairy.
                                            Receptacle long-exserted. (Celebes.) 10. *H. klabatense.*
                                            Receptacle slightly exserted. (Borneo, etc.) 9. *H. Bakeri.*
                                        Rachis decidedly hairy. (Philippines etc.) 8. *H. Meyenianum.*

Tube with conspicuous projections. (Solomon Islands.) .... 37. *H. gorgoneum.*

Lip of involucre with short, obtuse teeth.

Frond not coriaceous.

Frond ovate. (Solomon Islands.) .. 38. *H. gorgoneum.*

Frond lanceolate. (Philippines.) ...... 15. *H. Merrillii.*

Frond coriaceous, compact. (New Guinea.) 32. *H. ovatum.*

Lip of involucre with sharp teeth.

Frond ovate.

Walls not at all toothed.

Lips coarsely toothed. (Fiji.) .. 39. *H. feejeense.*

Lips minutely toothed. (Samoa.) 70. *H. praetervisum.*

Walls somewhat toothed. (Java, etc.) 18. *H. brachyglossum.*

Frond linear-lanceolate. (New Caledonia.) 31. *H. dimidiatum.*

Rachis winged throughout.

Wing not toothed.

Frond deltoid (cf. *H. Deplanchei*). (Mindanao.) 16. *H. Ramosii.*

Frond elongate.

Frond very hairy. (New Guinea.) .... 35. *H. Foersteri.*

Frond slightly hairy. (Malaya.) .. 17. *H. holochilum.*

Wing toothed.

Wing rolled in; teeth long. (Sumatra.) 24. *H. macrosorum.*

Wing plane. (Borneo.) .... 20. *H. Hosei.*

Wing somewhat crisped. (Malaya.) 19. *H. denticulatum.*

Wing contorted.

Stipe slightly hairy. (Malaya.) 21. *H. acanthoides.*

Stipe densely red-hairy. (Borneo.) 22. *H. carduncultus.*

Frond under 3 cm long.

Lips conspicuously toothed.

Fronds pinnate.

Walls uniformly thin. (Malaya.) .... 26. *H. blandum.*

Marginal walls toothed. (Borneo, etc.) .... 25. *H. Lobbii.*

Frond flabellate or pinnatifid.

Walls uniformly thin. (New Zealand.) 42. *H. Armstrongii.*

Walls irregularly thickened.

Rachis with toothed wing. (Australia.) 23. *H. kerianum.*

Rachis, if any, without toothed wing.
Segments under 1 mm wide. (Borneo, etc.)
25. *H. Lobbii.*
Segments much wider. (Philippines.)
28. *H. reductum.*
Walls thickened and pitted.
With marginal setæ. (Malaya.)........ 27. *H. johorense.*
With marginal teeth.
Walls much thickened. (Australia.)
41. *H. minimum.*
Walls slightly thickened. (New Guinea.)
30. *H. herterianum.*
Lips entire or slightly serrate. (New Guinea.)
29. *H. Rosenstockii.*

1. **HYMENOPHYLLUM RICCIAEFOLIUM** Bory. Plate 1.

Hymenophyllum ricciaefolium BORY, in Willd. Sp. Pl. V (1810) 531.
Sphaerocionium ricciaefolium PRESL, Hymen. 127.
Adiantum tenellum JACQ., Coll. Bot. 3 (1789) 287, *pl. 21, fig. 3.*
Hymenophyllum tenellum KUHN, Fil. Afric. (1868) 42, *non* Don (1825).
H. emersum BAKER, Syn. Fil. (1868) 457, teste 2d ed. 57.

H. frondibus bipinnatis, pinnis secundis, pinnulis inferioribus pinnatifidis, superioribus tripartitis, laciniis linearibus obtusis, soris terminalibus, indusiis obovatis, rachi alata, stipite marginato. W.

H. frondibus pinnatis, pinnulis decompositis decurrentibus, soris terminalibus. Bory in litt.

Adiantum (tenellum) frondibus bipinnatis, pinnulis lobatis, lobis oblongis. Jacq. collect. 3. p. 287. t. 21. f. 3*.

Riccienblättriger Hautfarrn. W.

Habitat in sylvis insulae Borboniae. 4 (v. s.)

Caudex repens filiformis laevis. Stipes pollicaris marginatus. Frons bipollicaris, circumscriptione oblongo-lanceolata, bipinnata. Pinnae fere semipollicares secundae. Pinnulae bilineares vel parum longiores, inferiores pinnatifidae, superiores tripartitae, summae denique bifidae, laciniis linearibus obtusis. Sori in apice frondis ad apicem laciniarum. Indusia obovata. Rachis alata. Jacquini figura, licet frondem minorem repraesentet, habitum satis bene exprimit. W.

The material available for the study of this species is very limited—two poor fronds, and the fragments accompanying the notes of van den Bosch—all in the Herbarium Lugduno-Batavum. He cites, as seen, specimens by Bory, Boivin, and Bernise from Bourbon, and Goudeot from Madagascar (Kuhn, Fil. Afric. 42, cites several more from Bourbon). I have verified his notes in the following important details: "Cellulis firmis opacis parvis imo minimis . . ., parietibus incrassatis diaphanis pulchre

minute crenulatis . . . Soris in laciniarum apicalium lacinulis terminalibus, magnis obovatis vel pyriformibus, indusio fundo conico . . ., valvis (sori totius ⅜ longis) late oblongis antice plus minusve truncato-rotundatis marginibus inaequaliter crenulatis, receptaculo clavato incluso (tandem elongato exserto).—" Except that I would call the receptacle narrowly cylindrical, and believe that it is normally exserted. The walls are everywhere minutely wavy, but the beautiful crenulation is only under the upper surface. The lacinæ seem normally to be slightly crisped, or at least wavy.

The affinity is to *H. edentulum;* which (as *H. macroglossum*) is probably responsible for the citation of this species from Ceylon.

2. **HYMENOPHYLLUM POLLENIANUM** Rosenstock. Plate 2.

Hymenophyllum pollenianum ROSENSTOCK in Meded. Rijks Herb. Leyden No. 11 (1912) 1.

Euhymenophyllum; rhizomate repente, filiformi, validiusculo, glabrescente; stipitibus subflexuosis, firmis, basin fere usque crispo-alatis, 2–3 cm. longis; laminis e basi parum angustata linearibus, obtusis, rigide membranaceis, fuscis, glaberrimis, subtripinnatifidis, 4½ cm. longis, 1½ cm. latis; segmentis primariis divergentibus, horizontalibus, ovatis, secundariis patulis, lacinulis linearibus, furcatis simplicibusque, valde crispatis, margine integro, apice obtuso vel acutiusculo, sinubus latis, rotundatis; rhachibus costisque crispo-alatis; soris apices frondis vel apices segmentorum summorum solum occupantibus, lacinulis haud abbreviatis insertis, mediotenus late alatis; indusiis e fundo urceolato ovalibus, ad ⅔ sori longitudinis bilobis, lobis obtusis, antice repandis vel integerrimis.

Hab. in insula Madagascar. POLLEN et VAN DAM.

Eine zwischen *H. Blumeanum* Spr. und *H. crispum* H. B. W. stehende Art mit derben Achsen und stark gekraustem Laub.—ROSENSTOCK, loc cit.

Herb. Lugd.-Bat. 911.91–28 bears the annotation label "*Hymenophyllum sp. prope H. tenellum* Kuhn. det. Rosenstock 1911," but I believe that it must be the type of *H. pollenianum.* The original label bears the collectors' names, no date, no locality more definite than Madagascar.

It is more divided and much more crisped than the specimens in hand of *H. ricciaefolium.* In their peculiar walls, the two are identical. The sori are few, and the material is so old and brittle that I have not tried to study the receptacle. The lip of the involucre is crenate. The differences from *H. ricciaefolium* are within the range of variation common with some commoner, better-known species (*H. badium, exsertum, javanicum*).

3. **HYMENOPHYLLUM MACROGLOSSUM van den Bosch. Plate 3.**

Hymenophyllum macroglossum VAN DEN BOSCH, Ned. Kruid. Arch. 5[3] (1863) 156.

H. tenellum auct. quoad plantam Zeylanensem, non Don.

Fronde ovata bipinnatifida, laciniis primariis patulis & divergentibus contiguis imbricatisque e basi oblique cuneata rhomboideo-oblongis, secundariis contiguis erectis simplicibus (vel dichotomis) elongatis late linearibus apice rotundato integris, rhachi latiuscule alata venisque flexuosis nigricantibus, cellulis opacis mediocribus hexaëdris subelongatis, parietibus tenuibus crenulatis hyalinis, interaneis amorphis diffusis e flavescente rubro-fuscis, marginalibus minoribus, soris in lacinulis abbreviatis apice constrictis subexsertis majusculis, indusio elliptico angustissime alato basi conico mediotenus vel ultra bilobo, lobis dilatatis erosis, receptaculo setaceo indusio duplo longiore, stipite apice anguste alato vix ultra 2 cent. longo. Rhizoma repens parce ramosum fulvo-hirsutum, frons 3–4 centim. longa, 2 lata membranacea firmiuscula ex olivacea fusca.

Indusium a receptaculum fere sunt *Leptocionii,* sed habitu et frondis margine integerrimo nimium ab hoc recedit et, pro tempore saltem, inter *Hymenophylla* enumerandum est.

Hab. Ceylon, THWAITES N. *3360.*—VAN DEN BOSCH, loc. cit.

Twaites 3360 is in the Gray Herb.; there also is another *Twaites* specimen ex Herb. Hance *15632* labeled *H. emersum;* and both there and in the U. S. Nat. Herb. are fragmentary Ceylon specimen ex Herb. Ferguson, called *H. tenellum* and *H. exsertum;* in Herb. Univ. Calif. is *"H. tenellum* Kuhn," *L. G. Wall;* these, and the type fragment in Herb. Lugd.-Bat., are one species, which, regarded as endemic in Ceylon, is well definable and recognizable. It differs from *H. ricciaefolium,* and still more from *H. exsertum,* in the much thickened and coarsely pitted walls; from *H. edentulum,* in being strictly entire, and probably in being less hairy; from *H. pachydermicum* in being less hairy, and having the basal pinnæ neither reduced nor narrowed to the base. In wall structure, *H. edentulum, H. macroglossum,* and *H. pachydermicum* are indistinguishable.

4. **HYMENOPHYLLUM PENANGIANUM Matthew and Christ. Plate 4.**

Hymenophyllum penangianum MATTHEW and CHRIST, Journ. Linn. Soc. Bot. 39 (1909) 214.

Trichomanes Hosei BAKER, Journ. Linn. Soc. Bot. 22 (1887) 223, *pl. 12;* COPELAND, Philip. Journ. Sci. 51 (1933) 137, *pl. 2, figs. 2–4; non Hymenophyllum Hosei* Copel. (1917).

Hymenophyllum semifissum COPELAND, Philip. Journ. Sci. 10 (1915) Bot. 145; CHRISTENSEN, Gardens' Bull. S. S. 4 (1929) 376.

Hymenophyllum leptocarpum COPELAND, Brittonia 1 (1931) 71.

A cause de son réceptacle sortant de l'orifice de l'urcéole, cette èspèce parait de prime bord appartenir au genre *Trichomanes*. Mais l'ensemble de la plante, son tissu fort mince, olivatre, et l'indusie non campanulé, mais ovale, la rougent plus naturellement parmi les *Hymenophyllum*. Le port est celui d'*H. lineare* d'Amérique ou d'une èspèce voisine, mais la plante est lisse, sauf quelques rares poils de la rachis.

Rhizomate filiformi repente ramoso breviter tomentoso. Foliis sparsis sed caespitoso-approximatis. Stipite nigro filiformi sed rigidiusculo pubescente 2 cm. longo. Fronde oblongo-ovato basi attenuato usque ad 7 cm. longo, 2 cm. lato. Rachi pilosa usque ad mediam laminam libera supra alata. Fronde pinnata usque ad bi-imo tripinnatifida, pinnis erecto-patentibus alternis, 6 ad 8 utrinque, inferioribus remotis, costa alata, usque ad 2 cm. longis, 9 mm. latis, oblongis, pinnulis 3 utrinque, inferioribus bi-aut trifidis, lobis ultimis obtusis 2 ad 3 mm. longis, 0.75 ad 1 mm. latis obtusis integris, nervis nigris conspicuis. Soris praecipue in axillis pinnarum antice, rarius in apice loborum superiorum positis, semiinsertis, ovatis, 1.5 mm. longis, valvis duabis manifestis semiovatis subintegris, receptaculo crasso exserto. Textura tenui diaphana, colore olivaceo, soris obscurioribus.

Hab. Penang, Government Hill, 2000 ft., Dec. 27, 1906; l. C. G. Matthew, 90.

The identity of the four "species" combined here is complete. I have not seen the original collection of *H. penangianum*, but *Holttum-Singap. Field No. 20998*, identified by Holttum, is from the type locality and fits the description well. I have already illustrated *T. Hosei* from a cotype (Trichomanes, pl. 2, figs. 2–4). For convenience, and to show the perfect identity, I illustrate it here using the type of *H. semifissum*.

Specimens: PENINSULA, *Holttum-Singap. Field Nos. 20998, 20565.* BORNEO, *Charles Hose 733, Brooks and Hewitt s. n., Bur. Sci. 2607 native collector* (type of *H. semifissum*), *Clemens 22018* (type of *H. leptocarpum*).

This species has been referred with professed confidence to both *Trichomanes* and *Hymenophyllum*. I refer it now to the latter, because it is without near relatives in *Trichomanes*, but is very evidently related to a large group here construed as *Hymenophyllum*. Specifically it may be nearest to *H. macroglossum*. The group as a whole may best be removed from both genera; when that is done this species can recover its oldest specific name.

5. HYMENOPHYLLUM PACHYDERMICUM Cesati. Plate 5.

Hymenophyllum pachydermicum CESATI, Atti Accad. Napoli 8 (1876) 8.

Hymenophyllum vestitum BAKER, Kew Bull. (1894), *teste* CHRISTENSEN, Gardens' Bull. 7 (1934) 213, *non* van den Bosch (1863).

Hymenophyllum halconense COPELAND, Philip. Journ. Sci. § C 2 (1907) 144.
Hymenophyllum taliabense V. A. VAN ROSENBURGH, Bull. Jard. Bot. Buitenzorg II No. 16 (1914) 18.
Hymenophyllum pilosum V. A. VAN ROSENBURGH, Bull. Jard. Bot. Buitenzorg II No. 16 (1914) 57.
Hymenophyllum Clemensiae COPELAND, Philip. Journ. Sci. § C 12 (1917) 46.

Dense caespitosum, rhizomate tenuissimo intricato, rufo-setuloso praesertim ad bifurcationes noduloso, stipites pariter tenues, apteros, plus minus setulosos, 1–3 centimetra longos emittente, abeuntes in rondem oblongam vel lanceolatam (si sterilis sit, subflabellatam brevem et aequilatam), duo decimetra longam, unam vel unum et semis latam, subtus rufo-hirtellam, copiosius ad nervos, pilis articulatis, bipinnatifidam. Laciniae planae, obovatae, lineares, obtusae vel truncatulae, lobulis 3–5, in frondibus sterilibus ad apicem densius barbatis. Cellulae parvae, obtusangulae, obscure hexaëdrae vel subrotundatae, parietibus sinuosis incrassatis ad typum cellularum ambliomorpharum Mettenii (in icone 35, tab. III, ejus dissertationis "*Über die Hymenophyllaceae*", p. 445, expressum), limbo interaneo lato turbido, centro hyalino: marginales magis quadratae, hinc inde singulis omnino opacis intermixis. Sori alares immerse elliptici, indusii tubo complanato, labiis ovatis acutis dimidium tubum metientibus, receptaculo filiformi duplo longiori.

Sarawak, in M. Gunong Poe.—Mese d'agosto 1866.—CESATI, loc. cit.

The description of the fronds as 2 dm long is an obvious misprint, for 2 cm. Fertile fronds seen vary in length from 1.5 to 6 cm. They are commonly a scant 2 cm wide, on stipes hardly that long and winged near the top or almost throughout; rachis winged, usually not very narrowly, the wing entire, rachis and ribs densely beset on the back with rusty to fuscous, somewhat deciduous hairs; pinnæ proximate, pinnatifid, with mostly simple, entire segments a scant millimeter wide, the lowest pinnæ usually reduced and (unless simple) with cuneate bases; internal cell walls very much thickened, and coarsely pitted, appearing coarsely and rather regularly toothed in optical section; sori on shortened lowest acropetal segments of pinnæ above the middle of the frond, involucre immersed or nearly free at the base, about 1.5 mm long, cleft about halfway down, tube hairy on the back, lips variable, usually broadly rounded and entire but sometimes narrowed, or emarginate, or very obscurely toothed, receptacle exserted.

Specimens: BORNEO, *Beccari* (type collection, Mount Poe), *Brooks 164*, *Clemens 10780* (type of *H. Clemensiæ*), *10226*, *22173*, *29270*, *50667*, *Topping 1619*, *Holttum Singap. Field No. 25618*. SUMATRA, *Matthew 631* (type coll. of *H. pilosum*), *Bur-*

chard 119. SULA-TALIABO, *Atje 216* (type coll. of *H. taliabense*). PHILIPPINES, *Merrill 6084* (type of *H. halconense*), *6085, Bur. Sci. 28412, 38769, F. B. 12107.* Van Alderwerelt has described a variety *nirmalanum* of his *H. pilosum,* from Java. From Sumatra there is a very ample series of specimens ex Herb. Waitz in Herb. Lugd.-Bat., which Rosenstock identified by description as *H. pedicularifolium* Ces. They fit fairly what there is of a description of that species; but, because it was described from as far away as Papua, and because they do represent another of Cesati's species, I do not accept the identification. They are *H. pachydermicum.*

I have in hand the type collections of all the "species" here combined (except the untenable *H. vestitum*). *Hymenophyllum pachydermicum, H. taliabense,* and *H. Clemensiæ* are identical. *Hymenophyllum halconense* has longer and laxer fronds, and *H. pilosum* has rather less extremely thickened walls; but these distinctions do not look diagnostic.

Hymenophyllum macroglossum, of Ceylon, has apparently less hairy fronds, with broader base. *Hymenophyllum pulchrum* is a local derivative with more ample, conspicuously symmetrical fronds. *Hymenophyllum edentulum* has the segments not quite entire. My only puzzle as to the name of the Bornean plants is founded on doubt as to the validity of this distinction from *H. edentulum.*

6. HYMENOPHYLLUM PULCHRUM Copeland sp. nov. Plate 6.

Rhizomate filiforme vix 0.2 mm crasso, intricato, piloso vel glabrescente; stipite 1.5 ad 3 cm longo, filiforme, sursum alato; fronde ca. 6 cm longa, 2 cm lata, anguste elliptica, fusca, bipinnatifida, rhachi late alata venisque inferne dense pilosis; pinnis late decurrenti-adnatis, oblongis, ca. 1 cm longis, 6 mm latis, oblique inciso-pinnatifidis, segmentis 1 ad 3 mm longis, 1 mm latis, apice rotundatis, integris; cellulis paullo elongatis, saepe rectangulis, parietibus apud superficiem primo minute crenulatis vel angulosis demum ibidem rectius incrassatis lineas angustas parietis externalis incrassatae emittentibus; soris axillaribus basi vix immersis, tubo 1 mm longo anguste alato, inferne piloso nigro, labiis brevioribus late triangularibus obtusis, receptaculo gracile exserto.

BASILAN (prope Mindanao), *Bur. Sci. 16214 Reillo,* September 8, 1912. Type in Phil. Nat. Herb.

A member of the group of *Trichomanes Hosei, Hymenophyllum edentulum,* etc., which, except for the hairiness (beneath) of rachis, veins, and involucre, I would suspect of being *H. ringens.*

The symmetry of the fronds and the uniformity of the closely placed pinnæ give this little fern a pleasing appearance.

6a. HYMENOPHYLLUM BATUENSE Rosenstock.

Hymenophyllum batuense ROSENSTOCK, Bull. Jard. Bot. Buitenzorg II No. 2 (1911) 22.

? Leptocionium; *rhizomate* tenui, repente, radiculoso, piloso; *stipitibus* tenuibus, teretibus, fusco-pilosis, sursum angustissime alatis, 1–1½ cm. longis; *laminis* oblongo-lanceolatis vel linearibus, olivaceis, c. 6 cm. longis, 2 cm. latis, bipinnatifidis; *pinnis primariis* lineari-oblongis, suberectis, subcontiguis, ala angustissima rhacheos inter se conjunctis, vel basalibus liberis, summis simplicibus furcatisve exceptis pinnatifidis, maximis 2 cm. fere longis, 7 mm. latis; *lacinulis* linearibus, apice retuso, integro, simplicibus vel basalibus furcatis, oblique porrectis, subparallelis, planis, integerrimis, 5 mm. fere longis, 1 mm. latis; *rhachibus* tenuibus, deorsum angustissime, sursum latius alatis, cum *costis* pilis fuscis subtus adspersis; *venulis* sub angulo 45° exeuntibus, longe ante apicem desinentibus; *soris* lacinulas basales pinnarum vix abbreviatas, infra sorum plerumque sinuato-angustatas, terminantibus, laciniis angustioribus e basi anguste conica elongato-oblongis, utrinque usque ad mediam marginatis, nudis vel raro basi appendiculatis seu indistincte cristatis, usque ad dimidiam fere bilabiatis; *labiis* elongato-triangularibus, productis, integerrimis vel apice minute crenulatis; *receptaculo* exserto, valido, incurvato, soro duplo fere longiore.

Hab.: Insel *Batu*, l. Raap No. 579.

Die Art hat grosse Ähnlichkeit mit einem weniger stark geteilten *Leptocionium holochilum* v. d. B., doch ist der Blattrand völlig ungezähnt. *H. edentulum* v. d. B., das einem *fast* ungezähnten Blattrand besitzt und hierdurch unsrer Art nahe steht, ist stärker geteilt, trägt mehrere Sori am Vorderrand der Fiedern und seine Indusien sind breiter und stehen auf längeren Lacinien.—ROSENSTOCK, loc. cit.

This species seems to belong in a group with the six preceding species, but, without seeing it, I cannot place it more exactly. It is antedated by all except *H. pulchrum* from which it seems to differ conspicuously by having a very narrowly winged rachis.

6b. HYMENOPHYLLUM HALLIERII Rosenstock.

Hymenophyllum Hallierii ROSENSTOCK, Bull. Jard. Bot. Buitenzorg No. 2 (1911) 23.

? *Leptocionium; rhizomate* validiusculo, lignoso, repente, glabrescente; *stipitibus* remotis, ad 5 cm. longis, usque fere ad basin distincte alatis; *laminis* c. 12 cm. longis, 3 cm. latis, oblongo-lanceolatis, sursum longe attenuatis, obscure olivaceis, glabris, subtripinnatifidis; pinnis primariis inframedialibus maximis, ad 3 cm. longis, 1–½ cm. latis, suberectis, ovato-lanceolatis, apice incurvatis, inferioribus ac superioribus simplicioribus, summis furcatis vel simplicibus; *pinnis secundariis* inferioribus recte patentibus vel paullo recurvis, flabellatim bipinnatifidis, ceteris obliquis et simplicioribus; *lacinulis ultimis* linearibus, apice rotundato emarginato; *rhachibus* cum *costis* subflexuosis, late alatis, glaberrimis; *venulis* vali-

diusculis, angulo acutissimo exeuntibus, sub emarginationem apicis desinentibus; *soris* lacinulas abbreviatas terminantibus, e basi conica subcylindricis, utrinque late alatis, usque ad ⅓ longitudinis bilabiatis; *labiis* ovato-triangularibus, acutis; *receptaculo* exserto, incurvato, soro duplo fere longiore.

Hab.: *Borneo*, l. Hallier No. 1791 ex p.

Auch diese Art würde zweifellos zur Leptocionium-Gruppe zu zählen sein, wenn ihr Blattrand auch nur eine Spur von Zähnelung zeigte. Durch das kurzlippige Indusium steht sie dem *Leptocionium Preslii* v. d. B. nahe, das sich ausser durch gezähnten Blattrand durch weit schwächere Achsen und weniger weitgehende Teilung der Lamina unterscheidet.

—ROSENSTOCK, loc. cit.

This species also seems properly to be grouped with the preceding one, and most to resemble *H. Lobbii*, but apparently distinctly larger, the fronds being about 12 cm long. I have not seen it.

7. **HYMENOPHYLLUM EDENTULUM** Christensen. Plate 7.

Hymenophyllum edentulum (van den Bosch) CHRISTENSEN, Index (1905) 360.

Leptocionium edentulum VAN DEN BOSCH, Ned. Kruid. Arch. 5^3 (1863) 148.

Fronde e basi lata rotundata ovata vel ovato-oblonga sursum angustata bipinnatifida, laciniis primariis patulis (infimis divergentibus) subcontiguis ovatis oblongisve apice adscendentibus, secundariis patulis remotiusculis dichotomis vel simplicibus (infimis pinnatifidis) lacinulis linearibus elongatis approximatis planis apice integro, margine dentibus parvis remotis obsito vel sub-integro rhachi flexuosa anguste marginata, inferne subterete, venis venulisque strictis nigrofuscis, cellulis opacis mediocribus, hic illic magnis hexaëdris acutangulis, parietibus pulchre spinuloso-dentatis hyalinis incrassatis, interaneis amorphis diffusis spissiusculis sordide olivaceo-fuscidulis, marginalibus minoribus semi-hexaëdris pariete exteriore minute crenulato, soris in laciniis secundariis lateralibus in lacinula parum abbreviata immersis mediocribus, indusio lacinulae latitudini aequali elliptico turgido mediotenus bilabiato, labiis integris vel obsolete denticulatis, receptaculo setaceo tandem exserto, stipite filiformi terete 1½–2½ cent. longo. Rhizome filiforme repens radiculosum glabrescens, frons 4–5 centim. longa, 2–2½ lata membranacea diaphana firmiuscula ex olivaceo fusca.

In speciminibus Assamicis denticuli marginales in lacinulis junioribus tantum conspiciuntur, indusii labia iis sunt integra; Borneensium denticuli in utraque parte evidentiores. Reliquis characteribus optime inter se conveniunt.

Hab. Assam, *Griffith;* Borneo (pr. Sarawak) *Th. Lobb* (H. Hook.).

—VAN DEN BOSCH (1863) 148.

This species will have to be studied at Kew before it can properly be understood. The Herbarium Lugduno-Batavum contains sterile fragments of the *Griffith* plant, but none of *Lobb's*. The pencil sketches, showing very evident marginal teeth and

denticulate lips, would seem to represent the latter. It seems, too, that van den Bosch had been in doubt as to the identity of the two. From one of the fragments I would think the lower part of the rachis was really terete. The walls are thickened to excess and coarsely pitted, as in *H. macroglossum*, *H. pachydermicum*, and related species. Except that *H. pachydermicum* is strictly entire, I would suppose it to be the Bornean component of *H. edentulum*.

Because I cannot see why they are not this species, rather than because I am sure that they are, I refer to *H. edentulum* specimens from the extreme north of the Philippines: *Bur. Sci. 28412, 33384, 78692, 78703, 78707, 78721, 78730,* and *80150;* the last has less-robust wall teeth, thus suggesting *H. Bakeri*, and, less immediately, *H. Meyenianum*.

I have felt out the propriety of making *H. edentulum* include *H. Bakeri, H. macroglossum, H. pachydermicum,* and *H. penangianum;* but have decided that the first is too different in the thickening of the walls, and that it is best to regard an entire margin as specifically distinct from one with even few and obscure teeth. It is certainly true, however, that this distinction, of general subgeneric value while *Hymenophyllum* has its present scope as a genus, is at most of specific value in this group. Of the small ferns with considerably thickened and toothed (pitted) walls, *H. edentulum* follows *H. ricciaefolium* and *H. holochilum* in priority of name.

8. HYMENOPHYLLUM MEYENIANUM (Presl) Copeland comb. nov. Plate 8.

Meringium Meyenianum PRESL, Hymen. (1843) 116, pl. 8, B.
Trichomanes Meyenianum VAN DEN BOSCH, Synopsis (1859) 39.
Hymenophyllum serrulatum (Presl) CHRISTENSEN, Index (1905) 367.
Didymoglossum serrulatum PRESL, Hymen. (1843) 115 *nomen*, 140.
Leptocionium serrulatum VAN DEN BOSCH, Synopsis (1859) 43.
Hymenophyllum bivalve J. SMITH, Hooker's Journ. Bot. 3 (1841) 418, *non* Swartz.
Hymenophyllum Smithii HOOKER, Sp. Fil. 1 (1844) 97, pl. 35B.
Leptocionium Preslii VAN DEN BOSCH, Synopsis (1859) 44.
Leptocionium violaceum VAN DEN BOSCH, Ned. Kruid. Arch. 5^{3} (1863) 147.
Hymenophyllum violaceum MEYEN, ibid., synonym.

Presl embodied the specific description in that of his genus *Meringium*, which follows:

Venae alternae, pinnatim ramosae venulisque subprominulae et apice libero desinentes. Sorus lateralis, subpedicellatus, basi bibracteatus. Indusii tubus breviter campanulatus, limbo bipartito, laciniis late ovatis obtusis

concavis demum divaricato-patentibus. Capsulae lenticulares, parti inferiori receptaculi filiformis crassiusculi indusio longioris affixae, sessiles.

Rhizoma repens, ramosum, filiforme, ramisque radicibusque paleis piliformibus horizontalibus rufis hirsutum. Stipes duos—semitertium pollicem longus, teres, paleis piliformibus flexuosis patentissimis vel divaricatis hirsutus, demum glabrescens. Frons (limbus) fusco-purpurea, tres-quatuor pollices longa, oblonga, basi nempe angustior quam versus apicem, pinnata, pinnis alternis petiolulatis lanceolatis acutis profundissime pinnatifidis vel si mavis pinnatis, in uno latere frondis majores quam in altero, laciniis vel pinnis secundariis sublanceolatis obtusis quinque-quadri-tri-bilobis, lobis linearibus obtusis angulo acuto interstinctis apicem versus argute serrulatis, infimis superioribus pinnularum superiorum in soros obliteratis et ita angustis ut pedicellum brevissimum mentiantur. Sorus ergo lateralis seu apparenter lateralis, subpedicellatus, multo major quam in Didymoglossi speciebus, basi bracteis duabus oppositis lineari-lanceolatis acutis serratis adpressis tubo indusii aequilongis instructus. Indusii tubus breviter campanulatus, limbus tubo duplo longior, profunde bipartitus, laciniis late ovatis rotundato obtusis concavis patentibus demum divaricato-patentibus. Receptaculum indusio triplo fere longius, filiforme, rigidulum, quemadmodum in Trichomanis paragrapho tertia Pachychaetum dicta crassiusculum, cicatriculis spiraliter ambientibus sub lente composita visum instructum, rectum vel curvatum. Capsulae in inferiori parte receptaculi affixae, lenticulares sessiles.

Non negandum, hocce genus Didymoglosso affine esse, differt tamen praecipue indusio, cujus tubus brevis campanulatus nec cylindracco-tubulosus, et cujus limbus profunde bipartitus, laciniis latis concavis demum divaricatis, nec laciniis tubo duplo brevioribus ovatis planis demum patentibus; demum differt receptaculo crassiusculo basi capsulas globoso-congestas gerente.—PRESL, op. cit. 116.

There is no doubt about the synonymy. After deciding it, and writing it up, I discover, *Herb. Lugd.-Bat. No. 910, 28–6*, an unpublished synonymy by van den Bosch, listing, under a name invalid and never published, the following synonyms: *Hymenophyllum Smithii* Hooker *quoad Cum. N. 164; H. violaceum* Meyen. in Herb. Berl.; *Meringium Meyenianum* Pr.

This is one of the commonest species of the Philippine mossy forest. Its distinctive characters are persistently setose stipe and rachis, the latter mostly winged but without teeth on the wing, dark brown lamina, segments more or less 1 mm wide, remotely and finely toothed, the axils webbed so that there is more or less uncut lamina from which the pinnules and segments spring, internal cell walls little thickened in the median plane of the lamina but much modified at the surface, involucre hairy at base, otherwise smooth or with inconspicuous longitudinal basal ribs, lips entire, receptacle stout, long-exserted.

Rhizome wide-creeping, densely hairy; stipe 3 to 5 cm long, dark, slender but firm; well-grown fronds commonly up to 10

cm long and 5 cm broad; pinnæ ovate to lanceolate, the lowest usually subopposite, reduced or not reduced; segments with one vein 0.7 to 1.3 mm wide; in correlation with the characteristic webbing of the axils, two veins may run to the end of an undivided segment, which is of course correspondingly broad. The teeth are very variable. Often a single cell constitutes a minute tooth, or one cell may rest on a base of two cells. Often the two cells rest on three; this may be regarded as the tooth most characteristic of the species. An aculeate tooth, with a series of more than two cells at its tip, is exceptional. The teeth are closest at the apices of segments, and may be forcipitate, bent together towards the apex. Away from the apex they become remote or disappear.

The thickening of the walls is variable and interesting. In the median plane of the lamina, the walls are more or less straight, and either thin or, less commonly, nodulose-thickened. When they present the latter appearance in optical section, the real condition is that they are reticulate-thickened, coarsely so, considering the dimensions of the cell. The area surrounded by a thickened line is a pit, although much broader than deep. A pit can occupy the whole height of the wall, but more commonly two or three of them do so. Exceptionally, no thickening at all occurs in the middle plane; this is the rule in *H. klabatense*, and is commoner in specimens from New Guinea and Mindanao than in the central area of the species—Luzon and the Visayan islands. Approaching both surfaces, the young wall is often but not always either finely crenulate or zigzag. The whole wall thickens there with age; and, if it is wavy or zigzag, thickened lines are formed along the inner face of the superficial walls, projecting from the original points or convexities. These look like teeth projecting from the lateral walls, and can be so called. If they always originated from the points just mentioned, they would necessarily be placed alternately on the opposite sides of an inner wall, which is by no means always the case. They are formed normally in all cells, whether or not the internal wall was originally straight. They project inward from the marginal walls, which of course were never crenulate or zigzag. The internal walls as a whole undergo less thickening than in the related group of *H. edentulum;* and the teeth are more slender, the pits correspondingly broader and shallower.

The thickened lines on the superficial walls are the beginning of a system of pits like that on the internal walls. Usually even the border pits are never inclosed; but sometimes the thick-

ened lines branch and more or less complete the formation of a row of pits around the cell. Rarely, they grow still farther; and very rarely the entire superficial wall of single cells becomes reticulate. Submarginal cells are most likely to develop in this fashion.

If not very numerous, the sori are produced in the axils of the lowest acropetal pinnules, or in the axils of otherwise simple or nearly simple pinnæ at the apex of the frond. In very full fruit, they occur in the axils of succeeding pinnules. They are sessile, wingless or winged for a short distance on the side towards the pinnule. The involucre is 2.5 to 3 mm long, 1.3 to 1.5 mm wide at the top of the tube, and cleft about halfway down, sometimes farther, very solid in texture. The tube is deciduously hairy at the base, and usually bears there about three very inconspicuous, short, longitudinal ribs (like those of *H. holochilum*). Each side bears a strong rib. As rare exceptions, various folds or projections are found on the tubes of individual sori; such structures may have been responsible for the "two opposite bracts" described and figured by Presl, who has been charged more than once with pure imagination in such details. The entire lips are broadly rounded, or more often narrowed to an obtuse point. Old and uninjured receptacles are likely to project by the length of the involucre.

Specimens: PHILIPPINES, *Cuming 221* (type collection of *H. serrulatum* in Gray Herb. and Phil. Nat. Herb.), *264; Bur. Sci. 5137, 9376, 9842, 13437, 14806, 14809, 14822,*[2] *14874, 15347, 19595, 19621, 28768, 29657, 29701, 35699, 35733, 35755, 37846, 38030, 38930, 41907, 43042, 45632, 47439, 48566, 48655, 48659, 76539, 76542, 76543; F. B. 4659, 7776; 7955, 7967; Clemens 17303, 17304; Elmer 6801, 7793, 9818, 9910a* (fronds up to 20 cm long and 8 cm wide), *12392; Whitford 165, 443, 918, 1509, 1511; Merrill 3233, 7489, 7498; Copeland 208; Topping 454, 820; Loher 13517; McGregor s. n.; Weber 1448.* NEW GUINEA, *Bamler s. n.* (*Rosenstock Fil., novoguin. exs. n. 342*), *Bamler 50d* (var. *cristulatum* Rosenstock), *Bamler s. n.* (*Ros. 209,* var. *cristulatum* f. *minor.*

The three *Bamler* collections from New Guinea are too alike to need naming as varieties or forms. They are not quite typical *H. Meyenianum,* being less hairy, with somewhat more-

[2] In Phil. Nat. Herb. In U. S. Nat. Herb., this number is *H. denticulatum.*

prominent teeth, and less-developed wall thickenings, but are within the range of variation in the Philippines.

Typical *H. meyenianum* has a definitely limited range within the Philippines. From Bontoc, south, it is typical. From north of Bontoc we have one specimen, *Bur Sci. 33305*, from Ilocos Norte, macroscopically typical, but with only a suggestion of the typical wall thickenings. From Mindanao there are few enough specimens to indicate rareness and none of them is quite typical. From Palawan the only similar specimen belongs to the Bornean race, which I prefer to hold distinct, as *H. Bakeri.*

Some affinity of *H. Meyenianum* to the group of *H. edentulum* may be postulated with confidence. It is especially related to *H. holochilum.* On the other hand, I mistrust any near connection with *H. multifidum,* although that species has been credited to Papua and Celebes, and even Philippine specimens have been given that name.

9. **HYMENOPHYLLUM BAKERI Copeland.**

Hymenophyllum Bakeri COPELAND, Sarawak Mus. Journ. 2 (1917) 309; CHRISTENSEN, Mitt. Inst. Bot. Hamburg 7 (1928) 143.

Trichomanes denticulatum BAKER, Syn. Fil. (1867) 82, *non* Houtt. *nec* Poir.

Rhizome slender, wide-creeping; st. slender, naked, ¼–½ in. l.; fr. 1–1½ in. l., ½ in. br., ovate or oblong, bipinnatifid, main rachis winged above, free below; pinnae pinnatifid down to a narrowly-winged rachis; ultimate segment linear, serrated, about ⅛ in. l., ½ in. br.; texture membranaceous; a costa only in each segment; sori 1 to a pinna, terminal on the lowest segment on the upper side, tube exserted, mouth with two bluntly triangular lips.

Hab. Borneo, discovered by the late Mr. Motley.—An interesting plant, combining the habit of *H. Tunbridgense* with the fruit of a *Didymoglossum.*—BAKER, loc. cit.

I ran the most classic of risks in giving a name to this species without having seen an authentic specimen. Christensen has consulted Baker's type, and says: "*H. Bakeri* ist mit *H. microchilum* sehr nahe verwandt, weicht aber ab durch die gesägten segmente." Perhaps I misconstrue one of these species, for I do not detect the affinity. I have from Doctor Christensen his var. *funebre,* which seems to be a form of the species I had in mind when giving the name, then represented in local herbaria by *Bur. Sci. 1523 native collector.*

This is in general a smaller fern than *H. Meyenianum,* with less hairy and very slender rachis, and narrower segments, and different structure of walls, but clearly related to that species,

and taking its place in Borneo, Palawan, Sumatra, and the Peninsula. It can reach the usual stature of *H. Meyenianum,* but 6 cm is a commoner length of frond, and it may be still smaller. The walls are only slightly thickened, broadly wavy where they come to the surface, with a long, narrow, thickened line running out from each convex curve or angle; in this way, each cell, in surface view, is bordered by a row of large, three-quarters-inclosed areolæ; and it is not rare for the areolation to be more complete and extensive. The sori are usually small, involucre cleft more or less halfway down, tube slightly, deciduously hairy on one side, otherwise smooth, lips rounded, entire, receptacle eventually exserted, but seldom visible.

Specimens: BORNEO, *Burbridge, Bur. Sci. 1523 native collector, Hewitt 34, Brooks 166, 175, Clemens 10779, 28005, Winkler 1042b, Native collector Sarawak Mus. 6.* MALAY PENINSULA, *Wray 3893, Holttum 18078, 19916, 19931, 20085, 20641, Henderson 18819B,* "State of Pahang" *13939.* SUMATRA, *Winkler, Ros. Fil. Sumat. 209, Barlett 7972.* PHILIPPINES, *Bur. Sci. 14809, 14822, Wenzel 959, Merrill 9517.*

10. **HYMENOPHYLLUM KLABATENSE** Christ.

Hymenophyllum klabatense CHRIST, Verh. Nat. Ges. Basel 11 (1894) 4.

Hymenophyllum multifidum CHRIST, Ann. Jard. Bot. Buitenzorg 15 (1897) 98.

As Christ's original publication is hardly in form a diagnosis, I describe the plant from the specimens in hand and present here his comment when, in error, he reduced it to *H. multifidum:*

"Form mit kurzen und seltenen Zähnen des Blattrandes, weit zurückstehend an Entwickelung hinter den Ex. Neuzeelands. Die Gipfelform ist kleiner." *Koorders 17136.*

The Herb. Lugd.-Bat. contains *Koorders 17136* (det. Christ) and four sheets in Herb. Waitz without other data than the place of collection, the summit of Mount Klabat.

Stipe 5 to 8 cm long, firm, deciduously hairy; frond 8 to 14 cm long, 3 to 5 cm wide, tripinnatifid, rachis winged nearly to the base, sparsely pilose; segments about 0.7 mm wide, 5 mm long, remotely and finely serrulate; internal walls thin and nearly straight in the middle plane, minutely crenulate, or when old finely toothed at the surfaces by short thickened streaks of the superficial walls; sori in the axils of the lowest acroscopic pinnules, sessile, hardly at all winged, involucre 2 mm long, 1 mm wide, cleft nearly or quite halfway down, tube hairy at base,

eventually smooth or with 2 or 3 short, obscure ribs, lips entire, obtuse, receptacle stout, much exserted.

Specimens: CELEBES, as already cited. MINDANAO, Mount Apo, *Copeland 1053.*

Hardly more than a local form of *H. Meyenianum* with less hairy axes, thinner walls, and narrower segments than are usual in that variable species. Not near to *H. multifidum,* to which it has been reduced, probably because of its narrow segments. Still less, of course, related to *H. polyanthos, H. badium,* and *H. javanicum,* with which Christ had previously compared it.

11. HYMENOPHYLLUM VITTATUM Copeland sp. nov. Plate 9, figs. 1 to 3.

Rhizomate 0.4 mm crasso, late repente, piloso; stipite 1 ad 2 cm alto, sursum rhachique anguste alatis haud dense pilosis; fronde 5 ad 6 cm longa, 2.5 ad 4 cm lata, fusca, vix tripinnatifida; pinnis ovato-lanceolatis, obtusis, pinnulis plerisque furcatis, segmentis 2 ad 3 mm longis, ca. 0.7 mm latis, obsolete serrulatis; cellulis paullo elongatis; parietibus laxe reticulatis, reticulatione superficiem totam saepe ornatim tegente; soris in parte superiore frondis ad pinnulas[I] vel rarius pinnulas[II] infimas plus minus abbreviatas seriatis, basi vix immerso, involucro 2 ad 2.5 mm longo, 1 ad 1.2 mm lato, medio fisso, tubo nudo ad basin interdum inconspicue striato, labiis integris, receptaculo valde extruso.

LUZON, Tayabas Province, San Antonio, *F. B. 13099 Curran,* (type in Phil. Nat. Herb.): Laguna Province, Dahican, San Antonio, *Bur. Sci. 10038 Ramos.*

The two collections are from approximately the same place, possibly from different sides of a provincial boundary.

This is a local derivative of *H. Meyenianum* from which it differs in its short stipe, less hairy axes, fewer teeth, rather narrower involucres, and more freely reticulate superficial walls. Some segments are quite entire.

12. HYMENOPHYLLUM BICOLANUM Copeland sp. nov. Plate 10.

Rhizomate intricato vix 0.2 mm crasso, subglabrescente; stipite 1 ad 2 cm alto, gracillimo, mox nudo; fronde usque ad 5 cm longa, 1.5 cm lata, fusco-viride, bipinnatifida, laxa, rhachi (nisi prope apicem) tereta, nigra, sparse pilosa; segmentis remotis, 3 ad 6 mm longis, 0.4 ad 0.6 mm latis, remote spinuloso-serrulatis; parietibus cellularum internalibus fere rectis tenuibus, obscure noduloso-incrassatis, hic ubi ad superficiem attingunt sinuato-crenulatis tantum irregulariter incrassatis et inconspicue denticuliferis; soris in locis segmentorum abbreviatorum infimorum pinnarum superiorum, 1.5 ad 2 mm longis, obovatis,

involucro vix ad medium fisso, tubo cuneato basi vix immerso inferne subnudo superne nudo, labiis late rotundatis, integris v. subintegris, receptaculo tantum exserto.

LUZON, Camarines Sur Province, Mount Isarog, altitude 1,200 to 1,500 m, *Bur. Sci. 76555 Edaño* (type in Phil. Nat. Herb.), *Bur. Sci. 76537, 76549 Edaño.*

Possibly referable to this species is a single collection from Catanduanes, altitude 30 m, with narrower and more compact fronds and less salient teeth, differences perhaps due to the environment.

A dwarf relative of *H. Meyenianum,* from which, besides in size, it differs in extreme slenderness and relative nakedness.

13. HYMENOPHYLLUM CAMPANULATUM Christ. Plate 11.

Hymenophyllum campanulatum CHRIST, Philip. Journ. Sci. § C 2 (1907) 155; *non* REINWARDT in van den Bosch, Hymen. Javan. (1861) 17, *nomen nudum.*

Leptocionium. Habitu omino *H. Tunbridgensis,* valvis integris, rhachi hispida.

Dense et late caespitosum, rhizomate tenui sed rigido ramosissimo, stipite rhachique nigris pilis rigidis hispidis, stipite 1.5 cm. tenui, fronde 4 cm. longa 1 cm. lata bipinnatifida oblonga, basi et apice attenuata, pinnis ca. 6 utrinque arcuato-reflexis, alternis, 1 cm. longis, flabellato-partitis, laciniis 4 aut 5, linearibus, vix 1 mm. latis, parce aristato-serratis. Soris raris, prope basin costae positis, pedunculatis, campanulatis, valvis erecto-patentibus ovatis, 2 mm longis. Textura rigidiuscula. Colore fusco.

NEGROS, [Occidental Negros Province], Mount Silay, (1549) *Whitford* May, 1906, alt. 1,100 m.—CHRIST, loc. cit.

The cotype in the Philippine National Herbarium seems to contain only two sori, on one frond, in a dense mat of sterile fronds.

Christ's description is accurate, as far as it goes, except as to size of sorus. The pubescence is sparse, of fuscous hairs; rachis terete below, narrowly winged upward; segments remotely and obscurely toothed. The walls are of the type of *H. edentulum,* but the thickening and toothing are only incipient. The sori (judging by those seen) are in the axils or places of the lowest acropetal pinnules, and sessile; involucre 1.5 mm long, split halfway down, with ovate, rounded valves; tube naked and smooth except for some deciduous hairs on the dorsal surface at the base, receptacle extruded. Although the tube is turgid, such an involucre is in no proper sense campanulate, wherefore I suspect that, though the whole description is of this *Hymenophyllum,* the name is due to the presence of fertile *Trichomanes parvulum.*

Besides the type collection, this species is represented by *F. B. 13605* and *13643*, also from Negros.

14. HYMENOPHYLLUM BONTOCENSE Copeland sp. nov. Plate 12.

Rhizomate ad truncos muscosos intricato, 0.2 mm crasso, glabrescente; stipite aequigracile, 1 ad 2 cm alto, piloso sed glabrescente, terete vel sursum marginato; fronde usque ad 6 cm alta, 2 cm lata, bipinnatifida, rhachi sursum anguste alata deorsum tereta vel marginata, inferne sparse setosa, segmento primo acroscopico saepe furcato; segmentis plerisque 1 mm latis, 3 ad 5 mm longis, minute argute serratis; parietibus cellularum plerisque tenuibus rectis, rarius denticulationem incipientem tantum monstrantibus; soris in locis pinnarum superiorum vel pinnularum primarum, involucris 3 mm longis, 1 ad 1.3 mm latis, medio fissis, tubo cuneato profunde immerso inferne varié minute cristato superne nudo, labiis protractis apice integris vel denticulatis, receptaculo incluso vel modo exserto.

LUZON, Bontoc Subprovince, Mount Pukis, *Bur. Sci. 37735 Ramos and Edaño* (type in Phil. Nat. Herb.) ; Mount Masapilid, *Bur. Sci. 37932 Ramos and Edaño,* altitude 1,500 to 1,800 m (type in Phil. Nat. Herb.).

Probably related to *H. barbatum* more than to any previously known local species.

15. HYMENOPHYLLUM MERRILLII Christ. Plate 13.

Hymenophyllum Merrillii CHRIST, Philip. Journ. Sci. § C 2 (1907) 154.

Leptocionium, ex affinitate *H. holochili* (v. d. B.) C. Chr., Javanici, caespitosum, minus, laciniis brevioribus, colore atrofusco, textura crassiore.

Rhizomate filiformi repente caespitoso, cum stipite rhachique pilis rufis brevibus parce vestito, stipite filiformi 3 cm. longo, fronde ovata acuminata versus basin attenuata 6 cm. longa, 2 cm. lata, bipinnatifida, pinnis confertis ca. 8 utrinque, cuneato-ovatis antice acutis sessilibus nec adnatis infimis petiolulatis 6 mm. latis profunde pinnatifidis, segmentis cuneato-obtusis 3 utrinque, profunde laciniatis, laciniis lanceolatis 2 mm. latis serrulato-dentatis planis, rhachi haud alata, soris infimae laciniae anteriori pinnarum insidentibus, pro pinna solitariis, 3 aut 4 utroque rhacheos latere, ovatis, 2.5 mm. longis, apice bivalvatis serrulatis, receptaculo crasso valde exserto. Colore atrofusco. Textura rigidiuscula.

LUZON, Province of Pampanga, Mount Arayat (1927 *Merrill*) October, 1904; Province of Bataan, Mount Mariveles (*Loher*) March, 1897, alt. 1,400 m.—CHRIST, loc. cit.

As in all relatives, the rachis is winged toward the apex of the frond. The real segments—that is, the ultimate divisions of the frond, containing a single vein—are not more than 1 mm

wide; the dissection is imperfect, so that there are uncut central areas of the pinnæ, 2 mm or more wide, where two or more veins run nearly parallel. The cell walls are irregular and slightly irregularly thickened where they come to the surface, but there is nowhere any appearance of regular teeth. The involucres are cleft more or less halfway down, the base of the tube ornate with a few hairs and stouter hairlike outgrowths consisting of two or three rows of cells, lips broadly rounded, denticulate.

LUZON, Pampanga Province, Mount Arayat, *Loher 849* (ident. by Christ as *H. multifidum*), *Merrill 3927* (cotype in Phil. Nat. Herb.), *Bur. Sci. 22444 Ramos:* Laguna Province, Mount Maquiling, *Bur. Sci. 13731 Ramos.* Endemic in central Luzon.

16. HYMENOPHYLLUM RAMOSII Copeland sp. nov. Plate 9, figs. 4 to 6.

Rhizomate late repente, 0.6 mm crasso, glabrescente; stipite ca. 5 cm alto, 0.6 mm crasso, rigido, nudo, fusco-nigro, sursum angustissime alato; fronde deltoideo-orbiculari, 6 cm longa et lata, basi quadripinnatifida, glabra, fusca, rhachi angustissime alata; pinnis tandem latissimis deinde imbricatis, infimis 3 ad 4 cm longis, 2 ad 3 cm latis, rhachibus aequi-anguste alatis; segmentis 3 ad 5 mm longis, ca. 0.7 mm latis, remote argute serrulatis, nec crispis nec undulatis; cellulis nullibi elongatis, parietibus rectis modo incrassatis minute vittatis, rarius dentibus brevibus latisque ornatis; soris plerisque ad pinnulas II infimas non abbreviatas terminalibus, basi vix immersis, involucro ca 1 mm longo latoque, fere ad basin fisso, nudo, labiis apice rotundatis, aut denticulatis, aut apiculatis, aut integris, receptaculo crasso-clavato, incluso.

MINDANAO, Bukidnon Province, Mount Lipa, altitude 2,000 m, on mossy trunks, *Bur. Sci. 38550 Ramos and Edaño* (type in Phil. Nat. Herb.).

A very distinct species, distributed as *H. serrulatum*, to which (*H. Meyenianum*) it probably has some remote affinity, agreeing in color and serrulation. It is a pleasure to dedicate another species to Maximo Ramos, who lost his life in Mindanao after three decades of zealous collecting.

17. HYMENOPHYLLUM HOLOCHILUM (van den Bosch) Christensen. Plate 14.

Hymenophyllum holochilum (van den Bosch) CHRISTENSEN, Index (1905) 226, 362.

Didymoglossum holochilum VAN DEN BOSCH, Plant. Jungh. 1 (1856) 561.

Leptocionium holochilum VAN DEN BOSCH, Synopsis (1859) 43, Hymen. Javan. (1861) 44, *pl. 34.*

Didymoglossum affine VAN DEN BOSCH, Pl. Jungh. (1856) 562 (not seen).

Leptocionium affine VAN DEN BOSCH, Synopsis 43, Hymen. Javan. 45, *pl. 35*.

Hymenophyllum affine RACIBORSKI, Pterid. Buitenzorg (1898) 20, *non* Brack. (1854).

Hymenophyllum Boschii ROSENSTOCK, Bull. Jard. Bot. Buitenzorg II No. 11 (1911) 24.

Hymenophyllum hamuliferum V. A. VAN ROSENBURGH, Bull. Jard. Bot. Buitenzorg II No. 28 (1918) 29.

Hymenophyllum Kurzii PRANTL, Hymen. (1875) 54.

Hymenophyllum lingganum V. A. VAN ROSENBURGH, Bull. Jard. Bot. Buitenzorg III 5 (1922) 208.

Fronde suboblongo-lanceolata bipinnatifida, laciniis primariis latiuscule ovatis secundariisque furcatis simplicibusque subcontiguis erecto-patulis; lacinulis latis subelongatis planiusculis denticulatis, denticulis brevibus remotis, e cellulis pellucidis magnis regularibus elongatis acutangulis globuloso-viridibus contexta, rhachi hirsuta inferne subobsolete marginata, soris immersis lanceolatis, tubo conico late marginato glabro, labiis subintegris tubum aequantibus, stipite s. terete s. obsolete alato subhirsuto fronde usque dimidio breviore.

Hab. ad truncos muscosos Javae; Herb. AL. BRAUN; in m. Salak, *Coll.* I N. 365 *a x* (in Herb. FRANQUEV.), *Coll.* I N. 215, ZOLLINGER.

Rhizoma setaceum horizontale ramosum parce hirsutum; stipes 3 fere centim. longus s. teres, s. angustissime alato-marginatus tenuiter paleaceo-hirsutus; frons 4–6 centim. longa, 1½–2 lata tenera membranacea diaphana viridi-olivacea lanceolata vel oblongo-lanceolata bipinnatifida, laciniis primariis erecto-patulis subaequidistantibus contiguis e basi cuneata plus minusve late ovatis, secundariis, inferioribus 1- rarius 2-furcatis, simplicibus furcatisve contiguis vel remotiusculis, lacinulis late linearibus parumper elongatis planiusculis, margine leviter undulatis sinuato-denticulatis, denticulis remotis inaequalibus latis brevibus obtusis, apice rotundatis retusisve; sori maximi in laciniis primariis axillares, in lacinula valde abbreviata immersi lanceolati, tubo late marginato conico glabro, labiis tubum longitudine aequantibus integris leviterve antice repandis, receptaculo setaceo tandem exserto?; rhachis superne latius, inferne s. anguste s. obsolete marginata venaeque et venulae validiusculae strictae; cellulae tenerae pellucidae magnae subaequales regulares elongato-hexaëdrae acutangulae, parietibus hyalinis rectis parum incrassatis, interaneis diffusis globulosis, globulis parvis viridibus; marginales minores subconformes pariete exteriore hic illic indistincte et minute crenulato.

—VAN DEN BOSCH, Hymen. Javan.

The essential distinctive features of *Leptocionium affine* were "parietibus diaphanis flexuoso-crenatis incrassatis," and "labiis tubo 3-plo brevioribus rotundato-triangularibus antice acute denticulatis." Both had the base of the tube ornamented by a band of longitudinal ridges or crests, and in most recent literature this has been the most emphasized feature of the species.

A small fern, with filamentous, glabrescent, mostly or wholly terete stipe, and rachis usually terete near the base, and with an entire wing in the upper part of the frond; frond plane or practically so; laciniæ serrate but with teeth less developed than those of *H. denticulatum*. Construing the two species of van den Bosch as one, it has a considerable range in specialization of walls, but not as much as his figures of *H. holochilum* would make one expect. A mere glance at his fragments shows that the perfectly smooth and even thin walls shown by figs. 6 to 9 of his plate 34 do not exist. The "parum incrassatis" of his text is more suggestive. They are somewhat nodulose-thickened in median optical section, and are more (but discontinuously) thickened, and more or less wavy, at the surface. In a few places, toothing is evident. I have nowhere detected teeth on the marginal wall. Although feebly developed, this modification of the wall is of the type better developed in the commoner *"L. affine"*—*H. Boschii*. The range in variation of development of thickening and irregularity is just about the same found in *H. Meyenianum*.

Perfectly authentic *H. holochilum*—that is, named by van den Bosch in distinction to his *L. affine*—exists on only two sheets, of which one bears only sterile fragments, and the other (ex Herb. Hasskarl) no well-developed sorus; what I find are *mediocres* at most, not *maximi*. In fact, I find in no herbarium (except for another *Hasskarl* sheet in Herb. Ludg.-Bat.) another specimen perfectly matching these in feeble differentiation of walls and in supposed sorus characters. The sori of what I call *H. holochilum* are in general not large. The involucre is cleft one-third to one-half of the way down or a little farther. The much emphasized ribs on the base of the tube can usually be detected on the dorsal surface only, the side of the frond somewhat hairy when immature. They are homologous with the crests of *H. denticulatum*. On one authentic sheet I find one of them free and bent at the upper end—becoming a tooth. And on two Papuan specimens I find them replaced by hairs, so closely appressed that only very careful study revealed the difference. The lips are more often entire than denticulate; thus they represent typical *H. holochilum*. But almost all specimens have the cell walls of *L. affine*. Rosenstock referred specimens from Borneo and Sumatra with entire lips to *H. Boschii* var. *euryglossa*. The receptacle is normally exserted. A form with acute lips and exserted receptacle was called var. *subgenuinum*

by van Alderwerelt, Bull. Jard. Bot. Buitenzorg II No. 20 (1915) 19.

For fifty years *H. holochilum* was regarded as endemic in Java. More recently it has been reported repeatedly from Borneo, Sumatra, the Peninsula, and Papua. Within the limits of variation of walls and lips already described, it is a well-defined species in Java. *Bünnemeyer 2057* from Banca, the type collection of *H. hamuliferum,* amply represented in Herb. Ludg.-Bat., matches Javan material perfectly. *Bamler* (*Ros. Fil. novoguin.*) *208* from Papua is typical except for the hairs already mentioned. His *208a,* var. *minor* Rosenstock, is sterile in our material, and therefore strikes me as a juvenile form. *Schlechter 16743* has the internal structure of *L. affine,* but the base of the involucre bears again some hairs but no ribs, and the lips are elongate, acute, and deeply toothed. *Drs. v. Leeuwen 9806, 9942,* and *10229,* unlike one another, may all be *H. holochilum,* but are notably hairy, short-stipitate, black, and finely divided.

Of Bornean specimens, *Topping 1707* and *1729,* and *Clemens 51214* and *51397,* all from Kinabalu, have some teeth on the wing of the rachis, the lips entire. *Elmer 21326* has minute sori, without ribs. From Sumatra, *Lörzing 6607* is most nearly typical, but has very small sori and a very narrow wing. *Winkler* (*Ros., Fil. Sumat.*) *208* in Phil. Nat. Herb. has the marginal teeth of *H. denticulatum;* in Herb. Univ. Calif. it is typical except for small sori. *Posthumus 785* is hairy and dark. Other Sumatra specimens, and all I have seen from the Peninsula, belong rather to the group or species of *H. edentulum.*

A cotype of *H. lingganum* is in the Herb. Ludg.-Bat. It is described by van Alderwerelt, but I find no satisfactory distinction from *H. holochilum*—as *H. Boschii*—unless it be that the serrulation is less evident. The structure and the sori match that form very well. The internal walls are toothed at the surface, but less thickened as a whole than those characteristic of the *edentulum* group.

Specimens: JAVA, *Hasskarl, Raciborski, Fleischer 21, Palmer and Bryant 316, 481, 513, Bakh van den Brink 1490B, 5878, 7088, v. Steenis 2791.*

Hymenophyllum holochilum is probably more nearly related to *H. denticulatum* than to any other of the better-known species with more ample fronds. It is still more nearly related to a plastic group of inconspicuous small ferns, with well towards as

many specific names as named specimens, characterized by size, form, and structure, but unstable in margin and fructification, sharing the characters of *Trichomanes* and *Hymenophyllum*, and not really at home in either genus. The group ranges from the Mascarenes (*H. ricciaefolium*) to Assam (?), Luzon, and Papua. In its absence of constant specific characters, the group is altogether like *Taschneria* in *Trichomanes*.

Hymenophyllum holochilum is probably the only Javan representative of this group. *Hymenophyllum Kurzii* Prantl has never been described so that it might be recognized with any confidence. It seems to have been meant to be distinguished by apical sori; and as this feature is not diagnostic, I presume that it is a chance or edaphic form of *H. holochilum*. Specimens are in the Munich Herbarium.

17a. HYMENOPHYLLUM RUFIFOLIUM v. A. van Rosenburgh.

Hymenophyllum rufifolium v. A. VAN ROSENBURGH, Bull. Jard. Bot. Buitenzorg II No. 28 (1918) 28.

From Sumatra, typified by *Bünnemeyer 925*, not seen. The author does not compare this with any other species, but the description suggests resemblance to *H. holochilum*. Frond 3 to 5 cm long; rachis winged in the upper part only, segments apparently few, 0.5 to 1 mm wide, remotely serrate with long teeth; involucre narrowly obovate, lips fimbriate-dentate.

17b. HYMENOPHYLLUM RUFIFRONS v. A. van Rosenburgh.

Hymenophyllum rufifrons v. A. VAN ROSENBURGH, Bull. Jard. Bot. Buitenzorg II No. 28 (1918) 28.

This is from Sumatra, described as very near "*H. serrulatum*," and based on *Brooks 295 / S*, which I have not seen. The base of the involucre is described as "extus minutissime glandulosa;" and the valves as "apice obtuso gracillime eroso-serrulatis," which distinguish it very sufficiently from *H. Meyenianum* and *H. Bakeri*. It is larger than *H. holochilum*—up to 15 cm in length of frond.

Apparently related to *H. holochilum* are the following six described species from New Guinea of which I have seen no authentic specimen:

17c. HYMENOPHYLLUM ELBERTI Rosenstock.

H. Elberti ROSENSTOCK, Meded. Rijks Herb. Leyden No. 14 (1912) 31.

Stipe 2.5 to 3 cm long; lamina 5 to 6 by 1.5 to 2.5 cm, brown, naked except for costæ and veins; pinnæ deeply pinnatifid; segments linear, the basal ones forked, acutely dentate; rachis

narrowly winged, sparsely hairy with "flavidis" hairs; sori near apex, involucre cut halfway down, lips subtriangular, obtuse, entire, receptacle long-exserted. *Grundler 2312.* Nothing in the description distinguishes it from *H. holochilum.*

17d. HYMENOPHYLLUM BREVIDENS v. A. van Rosenburgh.

H. brevidens v. A. VAN ROSENBURGH, Bull. Jard. Bot. Buitenzorg II No. 7 (1912) 20.

Leptocionium.—H. holochilo *C. Chr.* (forma typica) affine sed stipites longiores, crassiores, decidue longe ferrugineo-pilosi; frondes majores, ovatae, ca 12 cm longae, ca 9 cm latae, 4–5-pinnatae, rachidibus omnibus alatis et subtus decidue longe ferrugineo-pilosis, segmentis ultimis numerosis, ca ⅓ mm latis, margine non vel vix crispatis, remote brevi-serrulatis; sori in pinnulis subaxillares, indusio oblongo, 2-marginato, basi longitudinaliter cristato, lobis subtriangularibus, integerrimis vel obsolete repandis.

New Guinea (Johannes-Keyts Mountains, le Cocq d'Armandville No. 238).—V. A. VAN ROSENBURGH, loc. cit.

17e. HYMENOPHYLLUM TORRICELLIANUM v. A. van Rosenburgh.

H. torricellianum v. A. VAN ROSENBURGH, Bull. Jard. Bot. Buitenzorg II No. 11 (1913) 14.

Like *H. brevidens* in size and dissection. The differences are that it has longer, and acutely serrate segments; it is said also to be less freely soriferous and to have an extruded receptacle, but one need not doubt that that of *H. brevidens* is normally extruded. The type is *Schlechter 14543.*

17f. HYMENOPHYLLUM ELLIPTICOSORUM v. A. van Rosenburgh.

H. ellipticosorum v. A. VAN ROSENBURGH, Nova Guinea 14 (1924) 27.

Stipe 2 to 3 cm long, narrowly winged; fronds 3 to 6 cm long, 1.5 to 2.5 cm wide, "glabrae" (but "stipitibus, rachidibus, costis, costulis venisque pilosis"), subtripinnatifid; segments 7.5 to 10 mm long, 1.5 to 2 mm wide, serrate with oblique, longish, short-subulate teeth; sori "majusculi," involucre two-thirds cleft, base of tube hairy on the back, valves irregularly subdenticulate. Type: *Lam 1469,* Indenburg River, altitude 1,420 m.

17g. HYMENOPHYLLUM NUTANTIFOLIUM v. A. van Rosenburgh.

H. nutantifolium v. A. VAN ROSENBURGH, Nova Guinea 14 (1924) 27.

Stipe 4 to 6 cm long, black, naked or becoming so, sparsely rough; fronds 7.5 to 10 cm long, 6 to 7 cm broad, triangular or ovate, subquadripinnatifid, rachis winged, glabrous or glabrescent, wing entire; segments up to 5 mm long, 0.75 to 1 mm wide, short-serrulate or in places subentire; "indusium majus-

culum," one-third cleft, the back of the tube with 0 to 4 crests which may in part be dentiform, valves denticulate. Type *Lam 1470,* Doorman Summit, altitude 1,420 m.

Antedating the preceding five names, perhaps identical with one of them, but without a description sufficient to warrant an opinion.

17h. HYMENOPHYLLUM PEDICULARIFOLIUM Cesati.

Hymenophyllum pedicularifolium CESATI, Rend. Accad. Sci. Napoli 16 (1877) 24, 28; BAKER, Ann. of Bot. 5 (1891) 193.

Spherocionium, *H. asplenioidi* proximum, a quo differt: fronde subsessili, undulata s. crispula, supra glabra, subtus costulis rufo-pilosis; involucris magis elongatis.—CESATI, op. cit. 28.

Terra dei Papuas: m. Arfak ad Hatam (5–7000'); Juglio 1875.
—CESATI, op. cit. 24.

17i. HYMENOPHYLLUM CINCINNATUM Gepp.

Hymenophyllum cincinnatum GEPP, in Gibbs, Dutch N. W. New Guinea (1917) 68.

I have not seen this and place it with the preceding species of doubtful position because its author compares it with *H. holochilum.* The stipe, as well as the rachis, is winged throughout.

18. HYMENOPHYLLUM BRACHYGLOSSUM Al. Braun.

Hymenophyllum brachyglossum AL. BRAUN, in Kunze, Bot. Zeit. 5 (1847) 227.

Didymoglossum Braunii VAN DEN BOSCH, Pl. Jungh. 1 (1856) 560.

Leptocionium Braunii VAN DEN BOSCH, Synopsis 43; Hymen. Javan. 43, *pl. 33.*

Es unterscheidet sich durch kürzere Lippen der Hülle, lichtbraune Färbung und grössere Durchsichtigkeit des stumpferen und meist auch breiteren Laubes mit stärken Rande.—KUNZE, loc. cit.

The Herbarium Lugduno-Batavum contains ten sheets, mostly sterile, of this species, of which the most recent, so far as they are dated, was collected in 1861; most of them were identified by van den Bosch and they do not necessarily represent nearly ten distinct collections. The Gray Herbarium contains one (sterile) specimen, mounted as *H. denticulatum,* with hardly legible data, apparently collected on Mount Gedeh in 1846, perhaps a cotype; unlike the Leyden specimens, it has the rachis winged throughout, being perhaps juvenile.

This is smaller than *H. denticulatum,* the frond 3 to 5 cm long, 1.5 to 4 cm wide, bipinnatifid with the secondary divisions sometimes forked, not at all crisped; rhizome and stipe finely filamentous; rachis wingless in the lower part in all complete Leyden specimens, and the wing toothless where present

(as Blume in error described that of *H. denticulatum*); segments brown and without blackish margin or teeth, teeth long, mostly of two rows of cells; marginal walls mostly toothed on the inside ("fimbriato-crenulatis," van den Bosch), but in some places smooth and even; internal walls most variable in thickening, even on single fronds, in some places thin, and only slightly crenulate at the surface, in others closely beset with short, thick teeth; involucre cleft one-third to halfway down, with dorsal longitudinal ribs at the base but without free teeth, the lips rounded to subtruncate, fimbriate; receptacle extruded.

As most specimens seen are without fruit, I cannot appraise the diagnostic value of the ribs, instead of teeth, on the tube of the involucre. The partly terete rachis, absence of teeth on the wing where one is present, absence of blackening of margin and teeth, and fimbriate lips look like specific characters. But a Javan "species," supposed to be on the Gedeh, uncollected for over seventy years, must be either very rare or else merely a variant.

All specimens seen are from Java. It has been reported from Borneo; but the Kinabalu specimen, *Topping 1721*, to which I once applied this name is *H. denticulatum.*

This has been sufficiently illustrated, as *Leptocionium Braunii*, by van den Bosch, Hymenophyllaceæ Javanicae, pl. 33.

19. HYMENOPHYLLUM DENTICULATUM Swartz. Plate 15.

Hymenophyllum denticulatum SWARTZ, Schrad, Journ. 1800[2] (1801) 100 (not seen); Synopsis (1806) 148, 375.

Trichomanes denticulatum POIRET, Lam. Enc. 8 (1808) 75; BLUME, Enum. 226.

Didymoglossum denticulatum HASSKARL, Obs. Bot. 2 (1857) 16.

Leptocionium denticulatum VAN DEN BOSCH, Synopsis (1859) 42; Hymen. Javan. 39, *pl. 29.*

Hymenophyllum dichotomum CAVANILLES, Descr. (1802) 276?; NEES and BLUME, Nova Acta 11 (1823) 127, *pl. 13, fig. 4;* BLUME, Enum. 222.

Hymenophyllum humile NEES and BLUME, Nova Acta 11 (1823) 125, *pl. 13, fig. 3.*

Trichomanes Neesii BLUME, Enum. (1828) 226.

Didymoglossum Neesii PRESL, Hymen. (1843) 115.

Hymenophyllum Neesii HOOKER, Sp. Fil. 1 (1843) 99.

Leptocionium Neesii VAN DEN BOSCH, Synopsis 43, Hymen. Javan. 40, *pl. 30.*

Trichomanes aculeatum J. SMITH, Journ. of Bot. 3 (1841) 417, *nomen, non* Swartz (1788).

Didymoglossum aculeatum VAN DEN BOSCH, Pl. Jungh. (1856) 559.

Leptocionium aculeatum VAN DEN BOSCH, Synopsis 43, Hymen. Javan. 41, *pl. 31.*

Hymenophyllum aculeatum RACIBORSKI, Pterid. Buit. (1898) 21.
Didymoglossum ferox HASSKARL, Fil. Jav. 2 (1857–8) 17.
Hymenophyllum subrotundum v. A. VAN ROSENBURGH, Bull. Jard. Bot. Buitenzorg II No. 20 (1915) 19.

Frond. 3-pinnatifidis ovatis, pinnis dichotomis pinnulisque decurrentibus, laciniis linearibus obtusiusculis sinuato-denticulatis; soris supraaxillaribus. Java.—SWARTZ, Synopsis 148.

Habitat in Java. Thunberg.

Filix subspithamea.

Stipites e surculo repente, subcapillares, teretes, laxi glabri.

Frondes ovatae l. oblongae acutiusculae l. obtusae, 3-pinnatifidae, glabrae, fusco-virides, siccae fusco-brunneae.

Rachis flexuosa, submarginata, praecipue versus apicem frondis.

Pinnae alternae, ovatae dichotome subdivisae, patentes, pollicares, decurrentes, ut et

Pinnulae pariter alternae, divisae in lacinias lineares obtusas l. emarginatas, margine sinuato repando-denticulatas.

Denticuli nudo oculo subsetacei acuti, molliusculi nec rigidi.

Fructificationes supra axillas pinnarum terminalium solitariae, oblongae, erectae.

Indusia erecta, valvulis in cylindrum conniventibus.

H. dichotomum, Cav. prael. 1800, n. 668. huic simile, sed differt; pinnulis distinctioribus laciniis angustioribus margine magis flexuoso undulato, denticulis subspinulosis remotioribus, fructificationibus majoribus. —SWARTZ, Synopsis 375.

Rhizome and stipe wiry, hairy to glabrescent; a common size of well-developed frond is 7 cm long, 4 cm wide, on a stipe 2.5 cm long, the range upward being to about 10 cm long, lanceolate to ovate, usually with a broad base, the commonest degree of dissection being bipinnatifid with the larger pinnules forked; rachis usually winged throughout and the wing sometimes running to the base of the stipe, everywhere sharply toothed; frond plane, undulate, or slightly to very much crisped. An irregular marginal band, including the teeth, is almost always dark or even black.

There is great irregularity in the thickening of the walls, which is of the same type as in *H. Meyenianum* and *H. holochilum,* but in general less pronounced than in *H. serrulatum* and *H. edentulum.* In median focal plane, the internal walls are usually thin and more or less straight; less commonly, they appear nodulose-thickened, indicating that these walls are broadly, not deeply, pitted. Where they meet the superficial walls, the internal walls may remain thin, but there they are usually finely wavy, and very generally they are more or less thickened, with more or less development of short, stout teeth. This is practically never uniform in all mature parts of a single frond, and

the prevailing degree of thickening varies of course from specimen to specimen. There seems to be some correlation between thickening and crispiness, but I detect none between thickening and size or number of marginal teeth.

The involucres are cleft more or less halfway down. I find no correlation between depth of cutting and any other character. The tube is always beset with teeth or spinelike outgrowths; this development varies from feeble to fairly bizarre; it is imperfectly correlated with crispiness of frond. A few teeth can rarely be detected on the backs of the lips. The margin of the lips is always toothed at the ends, sometimes on the sides. Development in this respect varies from no more than three small teeth at the tip to a beautiful, even fringe of long ones. It is not correlated with crispiness.

I combine here three "species" which it has become customary to regard as distinct, *H. denticulatum, H. Neesii*, and *H. aculeatum. Hymenophyllum Neesii* was described by Blume (as *Trichomanes*), Enum. 226, immediately preceding his *T. denticulatum.* The descriptions are mostly literally parallel, and the only clear-cut difference is that the rachis of the former is described as undulate-spinulose, of the latter as "superne alata integerrina," which is not true of his own specimens in Herbarium Lugduno-Batavum, or of any specimen which I recognize as this species. The wing is toothed throughout, and it is only on a very few exceptionally lax specimens that I fail to find it and its teeth down to the base of the frond.

Not knowing *H. denticulatum* (Sp. Fil. 101), Hooker (Sp. Fil. 99) combined with *H. Neesii* (which he may have known only by the figure of Nees and Blume) the Philippine plant, *Cuming 146,* which J. Smith had called *Trichomanes aculeatum.* In this, his only follower seems to have been his disciple, Baker, Syn. Fil. 71. *Trichomanes aculeatum* was a synonym, not subject to transfer. *Hymenophyllum aculeatum* is thus invalidated as a name. But in this case I agree with Hooker, that *Cuming 146* is *H. Neesii;* and thus it is *H. denticulatum.* Other distinctions were introduced by van den Bosch. Thus *H. Neesii* was distinguished from the other two by having teeth on the back of the valves, as well as on the base of the involucre; I cannot see them on all specimens he called *H. Neesii.*

I believe that the general opinion has been that *H. denticulatum* was less crisped and less showily toothed than *H. Neesii,* while *H. aculeatum* should be the most crisped and toothed of the three. This may serve to distinguish them as typical forms;

but in every respect they intergrade, and there is no constant parallelism between the several criteria which have been held up as specifically distinctive. All forms are present in Java and in the Philippines; they intergrade in both lands; and it is my impression that the several forms are more directly related to the others in either one land than to the similar forms in the other. Therefore, I am constrained to regard them as a single species. It is not equally clear that I ought not to include also *H. acanthoides.*

I accept without question the statement of Christensen, Index Suppl. 3: 114, that *H. dichotomum* came from the Philippines, not, as published, from Chile. It is probably *H. Neesii.* I have already copied the comment of Swartz, who remains still the best authority on many of Cavanilles's plants. As a name, *H. dichotomum* has priority over *H. Neesii* but not over *H. denticulatum.*

Hymenophyllum ferox Hasskarl is described as quite typical *L. Neesii,* and was found on Mount Gedeh where *H. denticulatum* in various forms is common. I find no specimen bearing the name *ferox,* but the Herb. Lugd.-Bat. contains perfect evidence that Hasskarl did not know *H. denticulatum,* in the form of two sheets of it collected later (1858), one labeled by him *Hymenophyllum?,* and the other *Trichomanes?.*

Hymenophyllum subrotundum was described as "Hymenophyllo affini Rac. (non Brack.) affine." I have not seen the original collection; but *Posthumus 1082 bis,* so determined by the collector, in Herb. Lugd.-Bat., fits the description and in my opinion consists of young (not stunted) plants of *H. denticulatum.*

Range: Java to Ceylon, Assam, Luzon, and Fiji.

Specimens: JAVA, *Thunberg,* fragment in Herb. Lugd.-Bat., *Blume,* in same herbarium as *T. denticulatum* and *T. Neesii, Reinwardt, Korthals, Zollinger, Hasskarl, Junghuhn, Boerlage, Raciborski, Mousset* (*Ros. Fil. Jav. Or. 56*), *Bakh van den Brink 2386, 2394, 2606, 3336, 3369, 6150, 6500, 6963, 6964, 7040, Gerkens, Winckel 1309B, 1489B, Palmer and Bryant 359, 409, 464, 577, 588, 600, Buysman Herb. Anal. 46, 198, v. Leeuwen 10966.* SUMATRA, Herb. Weiss in Herb. Lugd.-Bat., *Bartlett 7979, 8477, 8482, Winkler, Yates 2486.* BORNEO, *Topping 1721, 1881, Elmer 20681, Clemens 11042, 50891, 51113, Winkler 2358, 3029.* MALAY PENINSULA, *Maingay 1739, Scortechini 502, Henderson Sing. No. 21671, 22092, Burkill and Holttum 8415, Holttum 9553, 16713, 20596, Nur 17400.* CEYLON, *Wall 1004, Beckett 202,*

Thwaites C. P. 2984. ASSAM. *Mann.* HAINAN, *Eryl Smith 1404.* INDO-CHINA, *Pételot 3328.* PHILIPPINES, *Cuming 146, Brackenridge, Loher 1196, Whitford 442, 795, 971, Merrill 3231, 6058, 6071, Williams 462, Copeland 209, Topping 819, Elmer 7034, 7976, Bolster 268, F. B. 16910, 19132, Bur. Sci. 9461, 13438, 13566, 19385, 23445, 29263, 29746, 30771, 30841, 31314, 33265, 40616, 41584, 41904, 48564, 77982, 79633, 80144.* FORMOSA, *Sasaki.* BALI, *Sarip* (Exp. Maier) *327, 404, 484.* NEW GUINEA, *Bamler* (*Ros. Fil. novog.*) *193, v. Leeuwen 9193* (with opaque cell contents). FIJI, *Parks 20007, 20191, 20204.*

20. HYMENOPHYLLUM HOSEI Copeland. Plate 16.

Hymenophyllum Hosei COPELAND, Philip. Journ. Sci. § C 12 (1917) 46; CHRISTENSEN, Mitt. Inst. Bot. Hamburg 7 (1928) 143.

Leptocionium lamina plana, rhachi late alata; rhizomate crasso-filiforme, glabrescente, laete fusco; stipite 10 ad 17 mm alto, fere ad basin alato; fronde 4 ad 5 cm alta, 2 ad 3 cm lata, ovata, bi-tri-pinnatifida, rhachi nigro-fusca, ubique late alata ala denticulis sparsis ornata; pinnis inframedialibus majoribus, ad alam rhachidium ipsarum pinnatifidis, pinnulis superioribus simplicibus, inferioribus furcatis vel rarius pinnatifidis cum 3 ad 5 segmentis; segmentis 2 ad 3 mm longis, 0.8 mm latis, obtusis, ubique anguste denticulatis, marginibus et dentibus nigrescentibus, lamina alibi fuscescente; soris in segmenta prima acroscopica pinnarum superiorium insertis, parte inferiore obconica immersa, receptaculo crasso-setiforme, labiis fere aequilongo, involucro extus deorsum denticulato vel aspero vel fere nudo, ca. ad medium fisso, labiis ovatis inconspicue dentatis.

Sarawak, Mount Trekan, altitude 600 meters, *Hose 730,* 1894–95.

Distinguished from otherwise similar species by the broad, flat wing of the rachis. The blackish margin is occasionally found in other species and may not be a constant character.—COPELAND, loc. cit.

I have seen the type collection only. Christensen cites two collections by Winkler from West Borneo.

A derivative of *H. denticulatum,* distinguished by the flat wing and nearly smooth involucre; perhaps better reduced to the parent species. It is usual for *H. denticulatum* in Borneo to be less crisped than is usual elsewhere. *Elmer 20681,* from Tawao, British North Borneo, is in fact plane with the closely placed teeth standing uniformly in the same plane, but the back of the involucre is quite ornate.

Narrow fronds are superficially like *H. edentulum,* but the toothed wing shows that it is not one of that group.

21. HYMENOPHYLLUM ACANTHOIDES (van den Bosch) Rosenstock. Plate 17.

Hymenophyllum acanthoides (van den Bosch) ROSENSTOCK, Bull. Jard. Bot. Buitenzorg II No. 2 (1911) 25; CHRISTENSEN, Mitt. Inst. Bot. Hamburg 7 (1928) 144.

Didymoglossum acanthoides VAN DEN BOSCH, Plant. Jungh. 1 (1856) 16.

Leptocionium acanthoides VAN DEN BOSCH, Synopsis (1859) 43, Hymen. Javan. (1861) 42, *pl. 32.*

Hymenophyllum sabinifolium BAKER, Syn. Fil. (1867) 71.

Hymenophyllum aculeatum et *H. Neesii* auct., in error.

Fronde a cuneato subovata bipinnatifida, laciniis primariis lanceolatis contiguis patulis, secundariis remotis erectis, lacinulis latiusculis elongatis undulatis crispato-squarrosis lacero-dentatis, e cellulis maximis regularibus valde elongatis subacutangulis flexuoso-crenulatis fuscidulis contexta, rhachi deorsum angustius alata, soris maximis semiimmersis ovatis, tubo rotundato conico dorso, pariter ac labia tubo aequilonga lacero-dentata, dorso aculeato, stipite apice alato frondem longitudine aequante.

—VAN DEN BOSCH, Hymen. Javan.

Hab. ad truncos muscosos Javae; in m. Gedé, v. GESKER; ibidem et in m. Salak, *Coll.* I. N. 562 (in Herb. Franquev.), N. 365 *ax* (in Herb. SONDER) et *Coll.* II N. 72, ZOLLINGER.

—VAN DEN BOSCH, Hymen. Javan. 42.

Rhizome and stipe densely hairy, tardily glabrescent, stipe 1 to 4 cm long, frond up to 5 cm (commonly, about 3 cm) long, deltoid to ovate, tripinnatifid with forked secondary pinnules; rachis winged throughout or nearly so, and the wing sometimes reaching the base of the stipe, crisped and toothed; all divisions of the frond about equally winged, moderately to exceedingly crisped, and bearing very long and irregular teeth; internal walls nodulose-thickened in optical section, more thickened and wavy or short-toothed where they reach the surface; sori large, sessile, winged at the base, involucre cleft more or less halfway down, densely and irregularly toothed along the margin and on the tube, and with some teeth even on the back of the lips, involucre extruded.

This is intimately related to *H. denticulatum.* The *v. Gesker* collection, probably to be regarded as the type, is its least differentiated form, with suberect pinnules, segments fully 2 mm wide including the teeth, and an uncut axial wing 1 mm wide which is only moderately crisped. A *Junghuhn* collection mounted on the same sheet (*Herb. Lugd.-Bat. No. 908, 279–482*), more spreading and more toothed, better exemplifies the species. *Zollinger 890,* probably the type collection of *H. sabinifolium,* is more spreading, with narrower lamina and more contorted and toothed. I illustrate the species by a specimen from Sumatra ex Herb. Waitz, mixed with *H. pavanicum, Herb. Lugd.-Bat. 908, 279–718,* a rather extreme form.

Specimens: JAVA, *Junghuhn, v. Gesker, Zollinger 890, Bakh van den Brink 2614, Kurz 291, Giesenhagen 88, Raciborski.* SUMATRA; (subject of Plate 17, collector unknown), *Lantemann. Winkler-Ros. Fil. Sumat. 206.* PENINSULA, *King's collector 1548, Henderson 17734, 18018, Nur 11739.* BORNEO, *Bur. Sci. 931 native collector.* PHILIPPINES, *Merrill 6059, Elmer 9825, 11799a, Weber s. n., Loher 13490, Bur. Sci. 9377, 10007, 12079, 16662, 17524, 19395, 19642, 20419, 28603, 28650, 29746, 30841, 31314, 33333, 33888, 37746, 38029, 38036, 39085, 41013, 41943, 44795, 78696, 78701, 78702, 79793.*

It is reported by Nakai, Bot. Mag. 40 (1926) 242, from Formosa, which is likely to be correct, as it is common at the north end of Luzon; but the characters by which Nakai identified it are a half-winged stipe and included receptacle, neither of which will serve the purpose. Also, Brause, Bot. Jahrb. 56 (1920) 45, reports it in two varietal forms from New Guinea; I have not seen them.

22. HYMENOPHYLLUM CARDUNCULUS Christensen.

Hymenophyllum carduncululs CHRISTENSEN, Mitt. Inst. Bot. Hamburg 7 (1928) 144.

Leptocionium rhizomate filiformi repente, pilis claro-brunneis sat dense vestito. Foliis remotis, stipitibus ad 3.5 cm longis, pilis mollibus claro-brunneis pubescentibus, versus apicem anguste alatis. Lamina deltoidea s. ovata s. oblonga s. oblanceolata, 3–5 cm longa, 2–3 cm lata, in siccitate brunnea, tripinnatisecta, infra ad rachin costasque rufo-pilosis. Rhachi costis venisque II et III ordinis aequaliter alatis; ala parenchymatica vix ultra 0.5 mm lata crispato-undulata nec plicata laceratim lobata, lobis e basi triangulari subito in 1–3 dentes subulatas crispatas contractis; segmentis ultimis remotis saepe divaricatis. Soris in apicibus segmenti basali acroscopici, ad medium valvatis, dorso e basi ad medium vel ultra dense spinosis, marginibus exterioribus acute dentatis, receptaculo breve exserto.

West-Borneo: Auf dem Bukit Mehipit, um 500 m, Urwald. (Hans Winkler n. 745, 10. Dezember 1924.)—CHRISTENSEN, loc. cit.

Christensen and Holttum, Gardens' Bull. 7 (1934) 215, report it from Mount Kinabalu, *Gibbs 4020, Holttum 25351, Clemens 29027.*

By Doctor Christensen's courtesy, I have a type fragment and *Holttum 25351.* I have only to copy his comment in the Gardens' Bulletin: "This species is very near *Leptocionium acanthoides* v. d. B. . . ., differing in the rather densely reddish pilose stipe and rachis." It does not require separate illustration,

which would only show the much more abundant hairs, but not their reddish color.

23. HYMENOPHYLLUM KERIANUM Watts.

Hymenophyllum kerianum WATTS, Proc. Linn. Soc. New South Wales 39 (1915) 767, pl. 87, fig. 6, not seen.

I have from Mr. C. T. White a part of the type collection from Frenchman's Creek, base of Bellenden Ker, on rocks, *W. W. Watts*, and a recent collection, *Brass 2172*, from Mossman River Gorge, both in North Queensland. It is a dwarf derivative or form of *H. denticulatum*, and could be regarded as that species if found in Java. As long as the normal *H. denticulatum* is unknown in Australia, *H. kerianum* may better be regarded as a derived species.

The stipe is about 1.5 cm long, mostly winged; frond 2.5 cm long, 1.5 to 2 cm broad; involucre moderately crested on the base of the tube; lips very prettily lacerate-dentate. The wing of the rachis is moderately crisped, and the margin everywhere rather sparsely toothed.

24. HYMENOPHYLLUM MACROSORUM v. A. van Rosenburgh.

Hymenophyllum macrosorum v. A. VAN ROSENBURGH, Bull. Jard. Bot. Buitenzorg II No. 16 (1914) 18.

Leptocionium.—Rhizoma longe repenes, filiforme, pilis longis, deciduis, ferrugineis ornatum. Stipites sparsi, filiformes, ca 1–4 cm longi, decidue pilosi, sursum alati. Frondes firmiter membranaceae, glabrae, lanceolato-oblongae, ca 2–8 cm longae, 1–2½ cm latae, 3–4-pinnatae, rachidibus alatis. Pinnae erecto-patentes, contiguae, sat undulatae, usque ad 2 cm longae et 1 cm latae. Segmenta ultima linearia, ca ¾–1 mm lata, marginibus (cum marginibus alarum) undulatae (crispatae) et dentatae, dentibus brevibus vel longi-subulatis; venulae in segmentis ultimis solitariae centralesque. Sori magni, ca 3–4 mm longi, axillares, in speciminibus minoribus ad pinnulas infimas anticas positi, in speciminibus majoribus magis copiosi; indusium profunde 2-valvum, basi obconicum, appendicibus longi-fimbriatis ornatum, valvis semiorbicularibus integerrimisque; receptaculum exsertum.

Sumatra (*Mt. Singgalang*, C. G. Matthew No. 705).

Known by the type collection, of which a frond is in the Herbarium Lugduno-Batavum. This has a filiform stipe 2.5 cm long, the frond 7 cm long, 2 cm wide, brown; the rachis and segments are rolled in rather than crisped; undivided segments up to 5 mm long; marginal teeth many, sometimes remarkably attenuate; cell walls very thin, straight, not modified at the surface.

The toothed wing of the rachis and the ornate tube of the involucre suggest affinity to *H. denticulatum*, but in other re-

spects—color, general aspect, cell walls, lips of involucre—it is very distinct.

From the same locality, Mount Singgalang, comes *Yates 2440*, in Herb. Univ. Calif., with identical huge sori, but absolutely without marginal teeth. Except for the sori, it is *H. polyanthos*.

25. HYMENOPHYLLUM LOBBII Moore.

Hymenophyllum Lobbii MOORE, in van den Bosch, Ned. Kruid. Arch. 53 (1863) 176; CHRISTENSEN, Gardens' Bull. S. S. 7 (1934) 214.
Trichomanes serratulum BAKER, Syn. Fil. (1867) 80.
Hymenophyllum subflabellatum CESATI, Atti Accad. Napoli 8 (1876) 8.

H. Lobbii MOORE in Hb. HOOK. Fronde lineari pinnata (pinnis anguste decurrentibus), pinnis patulis apice leviter incurvis contiguis obcuneatis sive 1–2 furcatis (quasi 2–3 fidis), sive pinnatifidis (utrinque lacinula unica), lacinulis subfastigiatis (quasi secundis) anguste linearibus planis margine serratis, dentibus remotis e basi angusta subulatis elongatis, cellulis firmis opacis regularibus hexaëdris acutangulis leviter elongatis, parietibus tenuibus sordide hyalinis rectis vel levissime dentato-flexuosis, interaneis diffusis spissiusculis grumulosis e viridi olivascentibus, marginalium pariete exteriore crenulato, rhachi filiformi flexuosa (excepto apice) pinnis decurrentibus angustissime alata, soris in fronde apicalibus exsertis parvis, indusio tubuloso aequaliter dilatato compresso basin usque bilobo, lobis antice truncato-rotundatis inaequaliter subulato-dentatis, receptaculo setaceo crasso indusio usque 2 longiore, stipite filiformi terete flexuoso 10–15 millim. longo. Rhizoma filiforme ramosum pilis fulvis facile detersis hirsutum, frons 3–4 centim. longa, 6–8 millim. lata membranacea subopaca firmiuscula rubro-fusca.

Hab. Ins. Malasicae, TH. LOBB? India orientalis (Assam), GRIFFITH (Hb. HOOK.).—VAN DEN BOSCH, loc. cit.

T. serratulum, Baker, *rhizome* slender, wide-creeping; *st.* slender, naked, about ½ in. l.; *fr.* under ½ in. l., about ¼ in. br., oblong, or subrhomboidal in general outline, pinnatifid down to a narrowly-winged rachis; *segm.* erecto-patent, in 2–6 pairs, linear, simple or forked, ⅛ in. l., under ⅛ in. br., toothed at the margin, texture membranaceous; a central *costa* only in each segment; spurious *venules* none; *sori* 1 to 2, terminal on the upper segments, the tube exserted or even stipitate, the mouth slightly two-lipped, deeply ciliated with sharp linear teeth.—BAKER, loc. cit.

The name ascribed to Moore is retained for this species with a grain of salt; perhaps a whole dose would be better. I have no reason to doubt the correctness of Christensen's statement that the same *Lobb* collection which provides the name served also as the type of *T. serratulum* Baker, and that Cesati's species is identical. But I have hardly more doubt that van den Bosch's description was based on the Assam plant, nor that the two plants cited by him are distinct. His herbarium contains neither fragment nor sketches of Lobb's plant. It does contain frag-

ments and sketches of Griffith's Assam plant, and the description is based wholly on this collection. It is probably the Himalayan plant which I construe as *H. barbatum* (*H. khasianum* Baker). I am as sure as one can be without seeing the Lobb collection that it is distinct; as one item, note Baker's description of the involucre of *T. serratulum* with "the mouth slightly two-lipped," and van den Bosch's "basin usque bilobo." The name "Lobbii" must, practically, belong to a Lobb collection, one being cited, even with doubt; and the type is explicitly in the Hooker Herbarium. But the publication under this name of the description of a different plant is dubious validation of Moore's *nomen nudum*.

A minute fern, with finely wiry stipe 6 to 8 mm long; frond flabellate-pinnatifid and up to 1 cm long and wide, or, when better developed, pinnate and up to 18 mm long, the rachis terete at the base, narrowly winged upward, pinnæ mostly forked, or the basal ones with two acropetal segments, segments 2 to 3 mm long, 0.7 mm wide, sharply serrate; cell walls thin and in general straight, marginal ones short-toothed on the inside, internal ones mostly wavy and irregularly somewhat thickened at the surface, but rarely at all toothed; sorus usually single and terminal, involucre about 1 mm long, wingless, naked, cleft hardly halfway down, lips rounded, aculeate-dentate at the ends.

Endemic in Borneo.

Specimens: BORNEO, Sarawak, *Beccari* (type of *H. subflabellatum*), *Bur. Sci. 1542 native collector, Clemens 20403;* Mount Kinabalu, *Clemens 28006;* Southeast (Dutch) Borneo, *Winkler 2489.*

I do not recognize the affinity of this dwarf to any better-developed species.

26. HYMENOPHYLLUM BLANDUM Raciborski. Plate 18.

Hymenophyllum blandum RACIBORSKI, Pterid. Buitenz. (1898) 20.

Rhizom fadenförmig, bis 0.2 m.m. dick, spärlich behaart. Blattstiele 1.5–2.5 c.m. lang, fadenförmig, sehr dünn. Lamina unregelmässig eiförmig, bis 1.5 c.m. breit, bis 2 c.m. lang, einfach gefiedert. Die unteren Blättchen gewöhnlich gegabelt, oder in drei Lacinien getheilt, sehr kurz gestielt, mit linearen 2 m.m. breiten, am Rande gezähnten Lacinien, die mittleren Blättchen mit verschmälerter Basis sitzend, ungetheilt. Zusammen sind 1, 2 bis 4 Blättchen an jeder Seite der dünnen, ungeflügelten Rhachis. Sori bis 1.5 m.m. lang, 1 m.m. breit; Indusialklappen gegen die Basis verschmälert, am Scheitel hoch abgerundet und gezähnt.

Epiphyt an Baumstämmen der mittleren Waldzone am Salak. Sehr dicke und ausgebreitete Polster bildend, die unteren Blätter sterben ab, an

der Oberfläche der Polster vegetiren neue. Verwandt mit H. Wilsoni. Ob es nicht vielleicht durch irgend welche Bedingungsgängen in der Entwickelung gehemmte Exemplare von H. affine Bosch sind, vermag ich nicht zu entscheiden.—RACIBORSKI, loc. cit.

The type being presumably in Buitenzorg, there are cotypes in Herb. Lugd.-Bat. and Phil. Nat. Herb. There are two subsequent collections from the same place by Bakh van den Brink, one of them, *5880*, mixed with a variety of sterile fronds I do not recognize as this species. Other collections are: Pahang, *Holttum 20776;* Philippines, *Bur. Sci. 14804, 76496, Merrill 6088, 6089, Elmer 9747a, 11690,* from southern Luzon and Mindoro to Mindanao. Reported from Borneo and Sumatra.

Rhizome, stipe, and terete rachis are as slender as possible; pinnæ 1 to 4 on a side, the upper ones connected by wings; teeth variable in length and attenuation but never hairlike as on *H. johorense;* cell walls very thin; sorus on a contracted segment, sometimes almost stipitate, involucre narrower than the normal pinnæ, lips conspicuously toothed, receptacle, when full-grown and unbroken, more than twice as long as the involucre.

Not related to *H. peltatum* (*H. Wilsoni*). The suggestion of affinity to *Didymoglossum* (not *Hymenophyllum*) *affine* van den Bosch is probably correct.

27. HYMENOPHYLLUM JOHORENSE Holttum. Plate 19.

Hymenophyllum johorense HOLTTUM, Gardens' Bull. 4 (1929) 408, with fig.

Rhizoma tenue repens. Stipites 2–5 mm. longi, glabri. Frondes raro plus quam 1 cm. longae et 1 cm. latae; ramuli dichotomi fere regulariter; ramuli tertiarii plerumque praesentes, quaternati non visi. Ramuli ultimi 1.5–2 mm. lati, usque ad 9 mm. longi. Margines leviter crispatae, pilis simplicibus numerosis rufo-brunneis deciduis munitae. Valvae indusii extra pilosae, apice rotundatae, margine dentatae, dentes pilosi, basi angustatae et ⅔ basin versus conjunctae; receptaculum tandem indusium longe 1 mm. superante.

JOHORE: Gunong Belumut, 3,000 feet. (Holttum 10755), in a close mat on tree trunk, among liverworts.

Rhizome slender creeping. Stipes 2–5 mm. long, glabrous like the main veins. Fronds rarely more than 1 cm. by 1 cm.; branching almost equally dichotomous; branches of third order usually present, but of fourth order not seen. Ultimate branches 1.5–2 mm. wide, and up to 9 mm. long in unequally branched fronds. Edges slightly crisped, bearing numerous simple red-brown hairs, which are somewhat deciduous on old fronds. Valves of indusium with hairy outer surface, rounded above, and toothed, the teeth bearing hairs like the edges of the frond; narrowed below and united for ⅓ of their length, the base forming a conical sheath round the receptacle which in age projects 1 mm. beyond the indusium.

This is perhaps nearest to *H. borneense* Hk., of which I have seen the type at Kew. The latter species differs however in having more palmate fronds with more slender segments, which are very hairy, and the indusial lips are much smaller.—HOLTTUM, loc. cit.

I illustrate this by the type, kindly lent me for the purpose by Mr. Holttum. Perfectly identical with it are three collections from the central Philippines: *Copeland s. n.*, from the summit of Mount Maquiling in 1909, misnamed *H. subflabellatum; Bur. Sci. 28468*, from Tayabas; and *76554*, from Mount Isarog, Camarines Sur. It is reported from Mount Kinabalu, Borneo, by Holttum, Gardens' Bull. 7 (1934) 214. The paucity of collections is probably due less to rarity than to the fact that it is inconspicuous.

I would say that the stipe is commonly about the length of the lamina, 1 to 1.5 mm long; and that tertiary segments are more often absent. A striking feature is that with age the dark color spreads along the entire margin from the hair-bearing teeth, and that by the time the sporangia are mature the margin of the lips of the involucre is dark to a depth of commonly four cells.

As to its affinity: As repeatedly remarked, these minute species must be considered individually, remembering always that resemblances which must result from reduction are therefore poor evidence of affinity. In spite of this fact, I am tempted to regard this specimen as "*Microtrichomanes*," and do place it in *Meringium* chiefly because of its walls. Christensen, Gardens' Bull. 7 (1934) 214, says it is not related to *H. borneense*, but compares it with *H. Lobbii*, from which "it differs chiefly by its segments being twice as wide." I do not regard them as related. The species from which it does differ in this respect, and not otherwise, is *H. Armstrongii.*

It is also exceedingly similar superficially to small forms of *H. blandum*, and the resemblance forces itself on the attention when they are brought in together, from Mount Isarog in southern Luzon. I do not believe, though, that they are even nearly related, and surely neither is a near relative of *H. tunbridgense.*

27a. **HYMENOPHYLLUM PERPARVULUM** v. A. van Rosenburgh.

Hymenophyllum perparvulum V. A. VAN ROSENBURGH, Bull. Jard. Bot. Buitenzorg II No. 16 (1914) 18.

Typified by *Matthew 664*, from Mount Singgalong, Sumatra, not seen. A dwarf, fronds up to 15 mm long and 7 mm wide,

naked, the rachis winged upward; pinnæ crowded, 3 to 5 on a side, simple or forked, segments about 1 mm wide, irregularly spinulose-denticulate; sori few, in the upper axils, involucre deeply cleft, with obconic base, and spinulose-denticulate lips. Christensen has suggested that *H. johorense* is possibly a later name of this species.

28. HYMENOPHYLLUM REDUCTUM Copeland sp. nov. Plate 20.

Rhizomate 0.2 mm crasso, obscuro, nudo; stipite 0.6 ad 1.0 mm alto, filiforme, nudo, terete; fronde ca 2 cm longa, dichotoma ramis (segmentis) 3 ad 5, basi anguste cuneata in stipitem transeunte, segmentis 5 ad 12 mm longis, usque ad 2 mm latis, adscendentibus, serrulatis, dentibus paucis, spiniformi-protractis; cellulis subelongatis, parietibus ob interanea dense applicata difficilibus visu, ad superficiem frondis undulato-crenulatis praecipue ad convexitates crenulationis incrassatis, ibidem interdum denticuliferis; soris in apices segmentorum tubo immersis, involucro 2/3 ad basin fisso, tubo cuneato dorso setifero et obscure corrugato, labiis late rotundatis dentibus in filamenta protractis ornatis; receptaculo labiis aequilongo.

PHILIPPINES, NEGROS, Cuernos de Negros, altitude 1,800 m, *Elmer 9747*. Type in Copeland Herb.

Similar and probably related to *H. johorense*, from which it is distinguished, among other characters, by the more immersed base of the receptacle.

29. HYMENOPHYLLUM ROSENSTOCKII Brause. Plate 21, figs. 1 and 2.

Hymenophyllum Rosenstockii BRAUSE, Bot. Jahrb. 56 (1920) 43.

Rhizoma scandens, tenuissimum, glabrescens, juventute cum petiolo pilis rufis setaceis articulatis instructum, folia interstitiis 0.3–2 cm longis emittens. Petioli tenues, 2–6 cm longi, teretes. Lamina usque ad 2.3 cm longa, 1–2.2 cm lata, pellucida, glaberrima, e basi truncata deltoidea vel e basi cuneata ovata, profunde bipinnatifida; segmentis I 2–4-jugis, confertis, infimis maximis, 1.5 cm longis, interdum subhorizontalibus, reliquis patentibus, pinnatifidis; segmentis II linearibus, maximis furcatis, 0.8–1.4 mm latis, margine argute serratis; rachibus nervisque validis, prominentibus. Sori superiorem laminae dimidiam partem occupantes, parci, singuli in segmentis I, nervos laterales basilares terminantes, 1-3-jugi, ca. 2.5 mm longi, 1.2 mm lati, indusio cupuliformi, bilabiato, labiis dimidiam indusii partem occupantibus in apicem paulo angustatum, rotundatum, integrum vel leviter serratum desinentibus, receptaculo crasso, 3–4 mm exserto.

Nordöstl. Neu-Guinea: Kaiserin-Augusta-Flus-(Sepik-) Gebiet: Hunsteinspitze, lichter Gebirgswald, dunkelgrünes Hymenoph., kleine Äste ganz umwachsend, 1050 m ü. M. (Ledermann n. 8842.—19. Aug. 1912),—Etappenberg, 850 m ü. M. (Ledermann n. 9087 a.—8. Okt. 1912).

—BRAUSE, loc. cit.

By the courtesy of the Museum Botanicum Berolinensis, I have a sterile frond of the type collection. Its internal walls are hyaline, moderately nodulose-thickened in middle optical plane, indicating that they are shallowly reticulate-pitted; they are crenulate at the surface, and then thickened, and in places short-toothed. This structure indicates affinity to *H. holochilum* or *H. Meyenianum,* but there is nothing in the gross aspect of the frond to support this indication.

Hymenophyllum Rosenstockii has presumably been evolved by reduction, and more complete knowledge of the local fern flora is required to make clear its affinity.

30. HYMENOPHYLLUM HERTERIANUM Brause. Plate 21, fig. 3.

Hymenophyllum herterianum BRAUSE, Bot. Jahrb. 56 (1920) 43.

Leptocionium e *H. tunbridgensis* (L.) Sm. affinitate. Rhizoma longe repens, filiforme, glabrescens, folia interstitiis 0.4–1.2 cm longis emittens. Petioli tenuissimi, glabri, teretes, 3–8 mm longi. Lamina e basi ± cuneata ambitu ovata vel deltoidea, 1–1.8 cm longa et lata, membranacea, pellucida, subbipinnatifida; segmentis 2–3-jugis, ala decurrenti ca. 0.5 mm lata conjunctis, infimis maximis, subhorizontalibus vel patentibus, furcatis, reliquis patentibus, linearibus; laciniis ca. 1.8 mm latis, margine acute serratis; nervis validis, prominentibus, simplicibus. Sori summam laminae partem occupantes, pauci, 2–3, nervos abbreviatos terminantes, indusio cupuliformi, bilabiato, labiis apice rotundato longissime dentatis, receptaculo valido, ca. 2 mm exserto.

Nordöstl, Neu-Guinea: Kaiserin-Augusta-Flus-(Sepik) Gebiet: Etappenberg, dichter Höhenwald, blaugrünes Hymenoph. im Moospolster der Baumstämme, 850 m ü. M. (Ledermann n. 8869.—30. Sept. 1912).

—BRAUSE, loc. cit.

This is also represented by a type fragment from the Berlin Museum. The marginal teeth consist of two or three cells in sequence, on a short base two or three cells wide. The internal walls are hyaline, uniformly slightly thickened, pore-pitted only, somewhat dilated where they come to the surface. The evidence of the anatomy is like that of the sori, to the effect that the superficial similarity of vegetative *H. herterianum* and *H. Rosenstockii* is no proof of affinity.

31. HYMENOPHYLLUM DIMIDIATUM Mettenius.

Hymenophyllum dimidiatum METTENIUS, Linnaea 35 (1868) 393.

Rhizoma?; folia membranacea siccatate olivacea, glaberrima, pinnatisecto-pinnatipartita; petiolus vix ½″ longus, teres, sub apice marginatus; rhachis segmentis decurrentibus basi interrupte anguste, superne manifeste continue alata; lamina 4½″ longa, 9′ lata, lanceolata; segmenta numerosa,

imbricata, patentia, dimidiato s. subdimidiato-oblonga s. ovata, obtusa, inferiora decrescentia, cuneata; laciniae 2–4, oblongae s. elongato-oblongae, obtusae, repando-dentatae, inferiores bifidae s. bisbifidae; sori lacinulam anticam infimam segmentorum superiorum occupantes, basi immersi, labia profunde distincta rotundata s. late oblonga, obtusissima, dentata s. fimbriato-dentata; receptaculum denique breve exsertum; paraphyses in basi receptaculi numerosae.

Nova Caledonia. (Deplanche in Herb. Lenormand.)

Ex folio unico descriptum, locum ad latus *Hym. secundi* Hk. Grev. capiat; segmentis minus manifesto-dimidiatis, laciniis numero minoribus magis divisis, soriferis solitariis, indusio obtusissimo fimbriato ab eo satis distinctum.—METTENIUS, loc. cit.

Rhizome 0.2 to 0.3 mm thick; stipe about 1 cm long, winged at the top, deciduously hairy; frond 5 to 10 cm long, lanceolate, bipinnatifid, rachis narrowly winged, without teeth, lowest pinnæ reduced, flabellate, middle ones nearly all dimidiate, with about two forked segments on the acroscopic side and none on the basiscopic; simple segments 3 to 8 mm long, 1.3 mm wide, serrate with spreading teeth near their apices, entire downward; cells mostly isodiametric or slightly elongate; marginal walls coarsely toothed on the inside; internal walls thin, straight, and, even in median optical section, dilated and toothed where they meet the superficial walls, and the teeth (thickened lines on the inside of the superficial walls), where best developed, becoming attenuate, eventually branching, and inclosing a row of large areolæ each with one chromatophore—this development of the walls not everywhere visible; sori immersed in obsolete axial segments, up to 3 mm long and 1.5 mm wide, cleft about halfway down, tube smooth, winged, lips broad with rather truncate, regularly laciniate-dentate apex; receptacle, so far as seen, included.

Endemic in New Caledonia.

Specimens: *Franc 1392, 1450; Ros. Fil. Nov. Caled. 133.*

An isolated species.

31a. HYMENOPHYLLUM SUBDIMIDIATUM Rosenstock.

Hymenophyllum subdimidiatum ROSENSTOCK, Meded. Rijks Herb. Leyden No. 11 (1912) 1.

From New Caledonia, typified by *Schlechter 14799,* not seen, and apparently not in the Leyden Herbarium. It is apparently similar to *H. dimidiatum,* but has entire lips of the involucre. Rosenstock's comparison of the two is practically useless, because *Schlechter 14757,* which he identified as *H. dimidiatum,* is the very different *H. Deplanchei.*

32. HYMENOPHYLLUM OVATUM Copeland. Plate 22.

H. (Leptocionium) ovatum COPELAND, Philip. Journ. Sci. § C 6 (1911) 70.

Rhizomate filiforme glabrescente; stipite 1 cm alto, rhachique sursum alata nigris, glabrescentibus; fronde ovata, 4 cm alta, 3 cm lata, obtusa; pinnis utroque latere ca. 9, proximis et interdum imbricatis, sessilibus; apice rotundatis, fere ad costam pinnatifidis; segmentis 1–2-lobatis, proximis; lobis ca. 0.8 mm latis, obtusis, sparse serratis, margine haud crispa, glabris, coriaceis, brunneis; indusio infra medium bifido, laciniis late ovatis, superne dentatis.

No. *B. 32*, Gira.

Clearly distinguished from all related species by the broad, very compact, and decidedly coriaceous little fronds.—COPELAND, loc. cit.

Still known by the type only. The published diagnosis contains one essential error; all costæ and veins are persistently ferruginous-hairy beneath, and naked and dark fuscous above. The hairs extend to the dorsal face of the tube of the involucre. The walls are very irregularly thickened and more or less (irregularly) toothed where they come to the surface.

In its coriaceous texture, fuscous color, and opacity, this is like a number of its New Guinea neighbors. It looks especially like an *Amphipterum*, but is without supplementary wings.

33. HYMENOPHYLLUM RUBELLUM Rosenstock.

Hymenophyllum rubellum ROSENSTOCK, Nova Guinea 8 (1912) 716.

Leptocionium; rhizomate tenui, longe repente, sparse paleaceo-piloso; stipitibus c. 5 cm. longis, ¾ mm. crassis, erectis, firmis, teretibus, badiis, nitidis, laminis deltoideis, longe acuminatis, rhachibus costisque exceptis glaberrimis, in sicco obscure rubellis, 3–4-pinnatifidis, ad 12 cm. longis, 10 cm. basi latis; segmentis primariis c. 15 utrinque, alternis, approximatis, subsessilibus, patentibus, saepe recurvis, basalibus plerumque maximis, ad 5 cm. longis, 2 cm. infra latis, lineari-lanceolatis, acuminatis, sequentibus subaequalibus vel sensim minoribus, supramedialibus citius abbreviatis et simplicioribus, cum summis apicem sensim et longe angustatum efformantibus; segmentis secundariis pinnarum inferiorum elongato-oblongis, acuminatis, approximatis; segmentis tertiariis majoribus pinnatifidis; ceteris furcatis vel simplicibus; laciniis anguste linearibus, obtusis, ad 2–3 mm. fere longis, vix ultra ½ mm. latis, margine serratis vel deorsum integerrimis; rhachibus costisque elasticis, ala angusta, plana, integerrima cinctis, pilis ferrugineis sparsis ornatis; soris apicem laminae occupantibus, axillaribus, laciniam anticam, abbreviatam terminantibus; indusiis e basi conica leviter ventricosis, utrinque anguste marginatis, bilabiatis, labiis aequaliter trigonis, ⅓ sori longitudinem fere aequantibus, integerrimis.

Hab. Nova Guinea neerlandica in summo montium Hellwig-Gebirge dictorum, 2583 m. s. m. Oct. et Nov. 1909, l. von Roemer No. 767 et 1305.

Die durch kräftigen Wuchs ausgezeichnete Art steht dem *H. serrulatum* Prsl. am nächsten. Sie unterscheidet sich von ihm durch die deltoide Gestalt ihrer Spreite und die, besonders im durchfallenden Licht, entschieden

rötliche Färbung des die starken, dunklen Rippen nur schmal umsäumenden Blattparenchyms. Auch sind die Lippen des Indusiums bei *H. serrulatum* länger (fast halb so lang als des ganzen Indusium).

—ROSENSTOCK, loc. cit.

A cotype, smaller than as described, is in the Herb. Lugd.-Bat. I have not ventured to study the sorus, as only one is present. The walls are thick and pitted.

This seems to me to be an isolated species, with the aspect of *Trichomanes* § *Macroglena,* rather than of any *Hymenophyllum.* The marginal teeth are very few, and the majority of what there are are single, obliquely protruding cells.

34. HYMENOPHYLLUM FIRMUM v. A. van Rosenburgh.

Hymenophyllum firmum v. A. VAN ROSENBURGH, Nova Guinea 14 (1924) 28.

Hymenophyllum subfirmum v. A. VAN ROSENBURGH, Nova Guinea 14 (1924) 28.

Leptocionium.—Rhizoma longe repens, gracile, cum stipitibus, rachidibus, costis venisque pilosum; pili partim decidui, partim persistentes, articulati, ferruginei, acuti; pili rhizomatis copiosi, longissimi, ceteri sensim minus numerosi, breviores. Stipites sparsi, 7½–15 cm. longi-parce punctato-verruculosi, parte inferiore nigri, parte superiore anguste 2-marginati, cum tota fronde obscure virides, in sicco nigri. Frondes firmae, potius coriaceae, costis venisque exceptis glabrae, ovato-lanceolatae ad deltoideae, 10–15 cm. longae, 5–15 cm. latae, acuminatae, basi 3-pinnatae; rachis basin versus 2-marginata, apicem versus anguste alata. Pinnae suberectae ad patentes, 14–18 utrinque; pinnae superiores breves, simplices vel furcatae; pinnae inferiores lineari-lanceolatae, usque 7½ cm. longae, ad vel supra basin 1 cm. latae; rachis anguste alata, ala integerrima. Pinnulae in pinnis longioribus usque 12 utrinque; pinnulae superiores simplices vel furcatae, inferiores ovatae vel oblongae, fere usque ad costam incisae, ala integerrima. Segmenta tertiaria in pinnulis majoribus 2–4 utrinque, maxima furcata vel duplicato furcata. Segmenta ultima breviter oblonga ad breviter linearia, 1–5 mm. longa, ½ mm. lata, obtusa, remote et obtusiuscule serrulata, hic illic integerrima. Sori in pinnis 1–4, in pinnulis axillares, solitarii, magni; indusium clavato-obovoideum, quam segmenta ultima ± 3-plo latius, obscure viride, in sicco nigrum, ± usque ad medium 2-valvum, basi obconoideum, cristis longitudinalibus, longioribus vel brevioribus et (vel) appendicibus ascendentibus vel erectis munitum; valvae breviter oblongae, integerrimae vel leviter repandulo-denticulatae, apice obtusiusculae ad rotundatae; appendices breves dentiformesque vel elongatae sublineares que, decidue ferrugineo-piliformi-apiculatae; receptaculum inclusum vel ± exsertum.

Habit.: Mountain ridge near Doorman Summit, epiphytical in forest, alt. 2480 m., H. J. Lam n. 1944, 10 November 1920.

—V. A. VAN ROSENBURGH, loc. cit.

The Herb. Lugd.-Bat. contains a cotype of *H. firmum;* also, *Drs. v. Leeuwen 10847,* Nassau-Geb., altitude 2,500 m, sterile, is the same species.

It is well characterized by the large fronds, long and narrow basal pinnæ, and narrow segments, with teeth mostly too small to be visible without a lens. The black dried fronds with opaque lamina are a local Papuan feature, as characteristic as is the odor of many New Zealand species. Cells mostly more or less elongate, contents fuscous, opaque, walls apparently hyaline, in spots evenly thin, but in most places crenate and nodulose-thickened, those of the *v. Leeuwen* specimen more thickened than those of the cotype. Involucre cleft one-third to halfway down, with broadly rounded, usually entire lips; tube always bearing coarse hairs at the base on both sides, sometimes with salient or reflexed teeth on one side, and rarely with ribs.

In spite of the teeth on the tube, it is on the whole nearer to *H. Meyenianum* than to *H. denticulatum.*

Both described by van Alderwerelt, *H. firmum* and *H. brevidens,* which I have not seen, are presumably distinct; in their descriptions the resemblances are more striking than the differences.

Hymenophyllum subfirmum, collected on the same trail but a thousand meters lower, does not seem to me possibly to be a distinct species. It is a little larger, a little more divided, not so nearly black; but these are differences in degree, and minor. The involucres are narrower, but the difference is not greater than is often found in other species. Found as they are, near together, I cannot doubt that more complete collection will show that they blend.

35. HYMENOPHYLLUM FOERSTERI Rosenstock. Plate 23.

Hymenophyllum Foersteri ROSENSTOCK, Fedde's Repert. 12 (1913) 165.

Leptocionium; rhizomate repente, filiformi, pilis ferrugineis hirsuto; stipitibus 2–3 cm inter se remotis, brevibus (1–2 cm longis), hirsutis, infra teretibus, sursum anguste marginatis; laminis c. 15 cm longis, 1–½ cm vel paullo ultra latis, linearibus, apice breviter acuminatis, membranaceis, in sicco lutescentibus, hirsutis, pinnato-pinnatifidis; pinnis numerosis, erecto-patentibus, alternis, breviter petiolatis (petiolis decurrenti-marginatis) trapezio-oblongis, obtusis, profunde pinnatifidis, ad 1½ cm longis, 6–7 mm latis; segmentis cuneatis vel linearibus, in lacinias 1–2 lineares fissis vel simplicibus; laciniis ad 2–3 mm longis 1 mm fere latis, margine dentibus membranaceis, e basi latiuscula acuminatis pilisque longis ferrugineis ornatis; rhachibus tenuibus, flexuosis, interrupte marginatis, cum costis venisque utrinque dense ferrugineo hirsutis; soris omnes fere pinnas occupantibus, solitariis, axillaribus; indusio conico, anguste marginato, usque ad ⅓ vel ½ bilabiato, dense hirsuto, labiis rotundatis, margine longe ciliatis.

Nova Guinea germanica, in montibus Bolan dictis, 3400–3800 m alt.; 1912, l. *C. Keyser, no. B. 31.*

Durch die dichte rostfarbige Haarbekleidung von den übrigen Arten der Untergattung *Leptocionium* leicht zu unterscheiden.—ROSENSTOCK, loc. cit.

Judging by the cotype in the University of California Herbarium, this is an excellent description. One frond is forked several times in the upper part. The marginal teeth are about horizontal, and consist each of a distal filament of three to eight short cells, on a broader base of varying length and width. They are unlike the teeth of any *Leptocionium,* and I do not suppose that this species belongs in that group. All axes are beset sparingly on the upper side, densely on the nether, with a tangle of weak, rusty hairs, three to eight cells long, and with a maximum length of at least 4 mm. The cells of the lamina are large, with thin, even walls. The sori are in the position of suppressed lowest acropetal pinnules, slightly winged at the base only; involucre 2.5 to 3 mm long, cleft less than halfway down, the tube black and variously warty near the base and everywhere hirsute, lips broadly rounded, densely ciliate with hairlike teeth, like those of the margin but with the bases almost obsolete; receptacle as long as the tube, cylindric, without sporangiophores.

Known by the type collection only.

An isolated species, with more the appearance of *Sphaerocionium* than of *Leptocionium,* and with the receptacle of *Euhymenophyllum.*

36. HYMENOPHYLLUM VIRIDE Rosenstock. Plate 24.

Hymenophyllum viride ROSENSTOCK in Herb. Lugd.-Bat., sp. nov.

Ab H. Macgillvrayi differt, fronde glabra, segmentis majoribus, receptaculis ut videtur inclusis. Stipite ca. 1 cm alto, gracile; fronde 5 cm alta, 1.5 cm lata, bipinnatifida, pinnulis infimis acroscopicis interdum furcatis, rhachi anguste alata, segmentis 3 ad 5 mm longis, 1.5 mm latis, serrulatis; parietibus tenuibus apud superficiem irregulariter subcrenulatis vix incrassatis; soris infra apicem frondis in segmenta fere obsoleta basi immersis, invulcro 2.5 mm longo, obovato, medio fisso, labiis integris vel subintegris, rotundatis vel obtuse apiculatis.

New Celedonia, montibus prope Yaouhe, altitude 500 m, *Schlechter 14799.* Type in the Herb. Lugd.-Bat.

This species and *H. Macgillvrayi* may belong in the group of *H. peltatum,* rather than in *Meringium.*

37. HYMENOPHYLLUM MACGILLIVRAYI (Baker) Copeland comb. nov. Plate 25.

Trichomanes Macgillivrayi BAKER, Ann. Bot. 5 (1891) 195.

Rhizome filiform, wide-creeping. Stipe slender, filiform, under an inch long. Frond oblong-lanceolate, bipinnatifid, glabrous, 1½–2 in. long; rachis winged down to the base; pinnae crowded, oblong-lanceolate, sharply serrated; secondary segments small, oblong. Sori one to a pinna, placed near the base on the upper side; indusium with a campanulate tube, and suborbicular entire lips. Fiji, *Macgillivray*. Near the Bornean *T. denticulatum* Baker.—BAKER, loc. cit.

Rhizomate intricato, 0.3 mm crasso, piloso pilis deciduis; stipite ca. 2 cm alto, gracillimo, ut rhizomate piloso; fronde usque 7 cm alta, 2 cm lata, bipinnatifida pinnulis majoribus acroscopicis furcatis v. bis furcatis, rhachi deorsum marginata sursum anguste alata, inferne pilulifera, segmentis brevibus vix 1 mm latis, inconspicue serrulatis; cellularum parietibus rectis tenuibus apud superficiem subsinuatis; soris segmenta acroscopica brevia impositis, involucro 2.5 ad 3 mm longo, medio fisso, tubo basi immerso, inferne decidue pubescente, labiis aut subacutis integris aut rotundatis et integris vel sinuatis, receptaculo valido prolongato.

FIJI, *J. Horne* (*52?*), collected in 1877–78. Distributed as *H. tunbridgense,* from which it differs, *inter alia,* in the mostly entire lips and long-extruded receptacles. In spite of these receptacles, the affinity to this group, particularly to *H. peltatum,* may be real.

After describing the *Horne* specimen as new, I have concluded that it can hardly be other than identical with that described in the wrong genus by Baker. However, I have not seen Baker's type.

38. HYMENOPHYLLUM GORGONEUM Copeland sp. nov. Plate 26.

Rhizomate ad truncos arborum scandente intertexto, 0.5 mm crasso; stipite 2 ad 3 cm alto, tereto, pilis rufis sparsis obsito; fronde ca. 8 cm longa, ovata, tripinnatifida, rhachi deorsum tereta sursum alata pilifera, pinnulis inferioribus flabellato-incisis superioribus dimidiato-pinnatifidis segmentis aut simplicibus aut furcatis paucis, brevibus, simplicibus ca. 0.7 mm latis, aculeato-serratis; parietibus marginalibus dentibus conspicuis irregularibus incurrentibus ornatis, internalibus in foco mediale nodoso-incrassatis, apud superficiem crenato-incrassatis denticuliferis; soris axillaribus sessilibus, involucro ca. 3.5 mm longo, vix ad medium fisso, tubo anguste obconico, marginato, utraque facie ad basin pilosa, deinde dentibus plerumque II longis crasse

piliformibus ornato, labiis rotundatis denticulatis vel subintegris, receptaculo non v. vix exserto.

SOLOMON ISLANDS, Ysabel, Tiratoña, altitude 600 m, *Brass 3304* (type in Phil. Nat. Herb.).

Except that the pinnules are less deeply cut, this looks like *H. multifidum, H. feejeense*, and *H. Deplanchei;* but in cellular structure and the cristate tube of the involucre it is more like *H. denticulatum* and Malayan species in general.

39. **HYMENOPHYLLUM FEEJEENSE** Brackenridge. Plate 27.

Hymenophyllum feejeense BRACKENRIDGE, U. S. Expl. Exped. 16 (1854) 266, pl. 37, fig. 2, *a, b, c.;* COPELAND, Univ. Calif. Publ. Bot. 12 (1931) 388.

H. stipitibus gracilibus teretibus glabris; frondibus late ovatis acuminatis pinnatis; pinnis alternis patentibus ovato-oblongis bi-tripinnatifidis, laciniis angusto-linearibus obtusis spinuloso-dentatis; rhachi flexuosa sursum marginata; soris terminalibus vel supra-axillaribus; indusio ovato bipartito, valvis superne argute serratis; receptaculo incluso.

HAB. Ovolau, Feejee Islands: on moist rocks and trees, at the elevation of 2,000 feet.

Plant very abundant in the above localities. Rootstock setose. Stipes 3 inches and upwards in length, *slender, smooth, terete. Fronds* usually about the same length as the stipe, elastic, *broad-ovate*, contracting into an *acuminate* point, *pinnate*, at least near the base, where the main rhachis is occasionally slightly margined, and usually with the secondary rhachis a little *flexuose. Pinnae alternate, spreading, ovate-oblong;* the inferior ones distant and tripinnatifid; the superior bipinnatifid; the *laciniae* short, *narrow-linear, obtuse, spinulose-dentate. Rhachis flexuose, margined* towards the upper portion. *Sori* few, confined to the upper half of the frond, and situated either on short *supra-axillary* laciniae, which is their usual position, or on the points of the outer laciniae. *Indusium* small, ovate, and split into *two valves* almost to its base, which is slightly immersed in the lacinia, the upper half of the valves *sharply serrated. Receptacle included.*

In habit and general characters this stands near to *H. bivalve*, Swartz; but it differs from that species in its slightly margined rhachis, and the sharply serrated indusium.—BRACKENRIDGE, loc. cit.

The type, in U. S. Nat. Herb., is very exactly matched by *Parks 20808* from Viti Leou, in most large herbaria; also *im Thurn 24* in U. S. Nat. Herb.? ex Herb. Kew.

In size and general appearance this is remarkably like *H. multifidum*, with which it agrees also in cell structure. The rachis is more narrowly winged, but the wing bears remote teeth where wide enough. The segments are a scant millimeter wide, and not quite so distinct at the base—that is, the sinuses are somewhat webbed. The fructification, however, is so different that I do not understand its reduction to *H. multifidum*, by

Baker in the Synopsis, and Christensen in the Index. The fertile segments are short but very evidently present, the involucre is much shorter, above 1.5 mm long and nearly as wide, cleft fully two-thirds of the way down, the lips thinner, broadly rounded or narrowing slightly upward, and conspicuously lacerate-dentate. The receptacle protrudes slightly on a few sori; in older material this might be more evident.

Fiji, as already cited. Sterile specimens from Samoa, *Vaupel 455,* and Aneityum, *Kajewski 871A,* may be this species.

40. **HYMENOPHYLLUM PRAETERVISUM** Christ. Plate 28.

Hymenophyllum praetervisum CHRIST, Engler's Bot. Jahrb. 23 (1896) 338.

Frons Hymenophylli tunbridgensis, soris 6 ad 8 terminalibus pedunculatis, apici segmentorum insertis infundibuliformibus, versus basin attenuatis, versus limbum campanulato-patentibus, profunde bilabiatis denticulatis saepe labiis reflexis, receptaculo longo et crasso exserto.

Zierliche Rasen an Farnstämmen bildend.

Savaii, Ostgebiet, 1000 m (Reinecke s. n.). Upolu, Kamm- und obere Flussgebiete (R. n. 63), Letogofluss-Falefaflussgebiet (R. n. 88), Falevao-kessel (R. n. 88^a). Tutuila, Matafaoflussbett, 500–600 m (R. n. 88^b). Manua-Inseln (R. n. 88^c).—CHRIST, loc. cit.

Rhizome wide-creeping, wiry, black, glabrescent; stipe 1.5 to 2.5 cm long, filamentous, naked, frond 2 to 4 cm long, 1.5 to 2.5 cm wide, bi- or tripinnatifid, rachis hardly marginate below, narrowly winged upward, segments up to 4 mm long, 1 mm wide, sharply serrate, teeth of one to three seriate cells on a broad base; internal walls hyaline, straight, slightly and uniformly thickened, unchanged at the surface; sori confined to the apex of the frond, one to eight in number, involucre 2 to 2.5 mm long, 1 mm wide, cleft one-third to one-half of the way down, tube narrowly obconic, base deciduously hairy, hardly at all winged, lip broadly or narrowly triangular, minutely but sharply toothed, receptacle exserted.

Specimens: SAMOA, *Reinecke 63, 88, 88, 88b; Whitmee 23; Betche.*

Domin, Bibl. Bot. 20 (1914) 21, doubtfully refers to this species a var. *australiense, H. tunbridgense* var. *exsertum* F. M. Bailey, Lithog. Ferns Queensland (1892) pl. 30. So far as Bailey's illustration and Domin's comments show, it might well be this species, but authentic specimens show that it is a distinct species—*H. pseudotunbridgense* Watts.

In describing *H. praetervisum,* Christ confused with it an entirely different Bornean plant mistakenly [cf. Christensen,

Mitt, Inst. Bot. Hamburg 7 (1928) 143] named *Trichomanes denticulatum* Baker.

Hymenophyllum praetervisum is a small representative of the austral group of *H. multifidum.*

41. HYMENOPHYLLUM MINIMUM A. Richard.

Hymenophyllum minimum A. RICHARD, Fl. Nouv. Zél. (1832) 91, 14, fig. 2; VAN DEN BOSCH, Ned. Kruid. Arch. 5^3 (1863) 175; COLENSO, Trans. New Zealand Inst. 13 (1881) 376 ff.; HOLLOWAY, Trans. N. Z. Inst. 54 (1923) 592, *pl. 67.*

H. perpusillum, surculis repentibus; fronde petiolata, pinnatifida purpurea, laciniis inferioribus profunde bipartitis obtusis argute serratis, indusio oblongo terminali, obtuso, semibivalvi, margine dentato.

Crescit in Nova-Zeelandia. (v. s. s.)

Descriptio.

Caespitosum, surculis ramosis radicantibus, filiformibus, subsquamatis, squamis linearibus raris.

Frondes erectae, solitariae petiolatae, vix unguiculares (petiolo tereti, 1–2 lineas longo), pinnatae, laciniis inferioribus profunde bipartitis, oblongis obtusis margine argute serratis glaberrimis purpureis, medio longitudinaliter plicatis. Indusium frondem terminans, solitarium subpedicellatum, basi sensim angustatum spinulosum, apice obtusum semibivalve, valvis margine dentatis. Sporangiophorum inclusum subpedicellatum, apice muticum.

Observations.

Cette espèce est probablement la plus petite de tout le genre. Elle forme des touffes serrées qui croissent mélangées au milieu des Mousses et des Lichens. Elle se rapproche par son port des *Hymenophyllum pusillum* Gaudichaud, et *H. tunbridgense.* Mais elle diffère du premier par ses frondes offrant des dents très-aiguës, et du second par la forme de ses frondes simplement pinnées, a dents très-aiguës, et surtout par la forme et la position de son *indusium* qui est terminal et non placé le long des nervures comme dans la seconde espèce.—RICHARD, loc. cit.

I have seen no original specimen. Van den Bosch does not say that he saw one, and there is no fragment in his herbarium; but he must have had one, because he cites Herb. Franq. and notes "bona" as to Richard's figures, and because his unpublished notes amplify these. By means of his (van den Bosch's) sketches, and not otherwise, I can confirm the identification of a Stewart Island collection, *Kirk 574,* in U. S. Nat. Herb. J. D. Hooker had already reported it there, but it seems clear that neither Hooker ever saw an authentic specimen. The elder Hooker reduced both this and *H. antarcticum* to *H. tunbridgense;* regarding the two reduced species, van den Bosch well says, "Tanta autem illarum est diversitas, ut ne unico charactere inter

se conveniant." The best discussion of *H. minimum* is by Colenso, who likewise avowedly never saw it.

Sterile fronds vary from simple and about 5 mm long, through bifid and bifoliolate to pinnate with up to four pinnæ on a side, the fronds 1 cm long; rachis in the most ample specimens hardly marginate at base, black; undivided pinnæ 3 to 4 mm long, 2 mm wide, obtuse or truncate, margin armed with spinulose teeth; walls thick and pitted; sorus terminal, involucre variable in size and shape, commonly obovate and 2 mm long, sometimes narrower and longer, cleft less than halfway down, base cuneate and wingless, with spinulose teeth on the back, lips broadly rounded, with long, fine teeth, receptacle exserted.

Described from New Zealand, probably Tasman's Bay; credited to Lord Howe Island by Bentham; seen from Stewart Island.

42. **HYMENOPHYLLUM ARMSTRONGII Kirk.** Plate 29.

Hymenophyllum Armstrongii KIRK, Trans. New Zealand Inst. 10 (1878) XLIII, *pl. 21, fig. A.* (not seen).

Trichomanes Armstrongii BAKER, Syn. Fil. (1868) 452; ed. 2 (1874) 465.

Hymenophyllum melanocheilos COLENSO, Trans. New Zealand Inst. 17 (1884) 255.

T. Armstrongii, Baker; *rhizome* capillary, wide-creeping; *st.* filiform, $\frac{1}{8}$–$\frac{1}{4}$ in.; *fr.* $\frac{1}{2}$ in. l., simple or forked or flabellately divided, with few blunt simple or lowest rarely forked 1-veined ligulate erecto-patent divisions, $\frac{3}{4}$–1 in. br.; border as distinct as the midrib, bristle ciliated; *surfaces* glabrous; *sori* 1–4 to a frond, terminal on the lobes, minute, obconical, immersed, with rounded ciliated lips.

Hab. New Zealand, *Armstrong.*—BAKER, Syn. Fil. (1874) 465.

From the other minute species described from the same region—*H. minimum* Rich., *H. Moorei* Baker, *H. pygmaeum* Colenso—this is clearly distinguished by being dichotomous or flabellate, not pinnate or pinnatifid. The others all represent the group which has been called *Leptocionium;* but this is ciliate instead of toothed, and is a *Microtrichomanes*, or dwarfed *Sphaerocionium*. It is thus somewhat related to the other species which it most resembles, *H. johorense*, of the Malay region, from which, however, it differs essentially in having uniformly thin walls. The available material is so fragmentary and so nearly sterile that I have not examined the receptacle. The sporangium is that of a real *Hymenophyllum*.

The U. S. Nat. Herb. contains *Kirk 138* and *383*.

I have not seen *H. melanocheilos*, but accept the reduction already made, having arrived at it myself by description. Co-

lenso called it a relative of *H. marginatum,* but a *Pachyloma* with toothed margin is hardly possible.

Endemic in New Zealand.

43. HYMENOPHYLLUM MULTIFIDUM (Forster) Swartz. Plate 30, figs. 1 to 3.

Hymenophyllum multifidum (Forster) SWARTZ, Schrad. Journ. 1800[2] (1801) 102, Synopsis 149, 378; SCHKUHR, Krypt. Gew. 133, *pl. 135, b;* HOOKER and GREVILLE, Ic. Fil. *pl. 167.*

Trichomanes multifidum FORSTER, Prodromus (1786) 85.

Hymenophyllum truncatum COL., Trans. N. Z. Inst. 23 (1890) 390.

Hymenophyllum alpinum COL., Trans. N. Z. Inst. 31 (1898) 263.

Hymenophyllum oligocarpum COL., Trans. N. Z. Inst. 31 (1898) 264.

T. multifidum, frondibus decompositis: foliolis alternis pinnatis: pinnis dichotomis linearibus decurrentibus argute serratis: fructificationibus ovato-subrotundis dehiscentibus. F.—FORSTER, loc. cit.

Frond. decompositis, pinnis decurrentibus dichotomis, laciniis linearibus argute serratis; soris supraaxillaribus solitariis. (*H. fucoidis affine.*)

Trichomanes multifidum. Forst. prcdr. n. 473. Ins. maris pacifici.—SWARTZ, Synopsis 149.

Stipites e surculo filiformi, repente, longi, filiformes, laxi, teretes, glabrae.

Frondes subtriangulares, acutiusculae, 2–3-pollicares decompositae, 3-pinnatifidae, glabrae, curvatae, diaphanae. *Rhaches* flexuosae, marginatae.

Pinnae decurrentes, patentes, dichotomae remotiusculae, pinnulis distinctis.

Laciniae lineares, angustae, apice obtuso integro, margine argute serratae.

Fructificationes supra axillas pinnarum et pinnularum solitariae insidentes, majusculae. *Columella* inclusa.

Valvulae indusiorum obovatae, compressae, integerrimae.

Observatio.

Affine *H. fucoidi* at diversum: forma frondis–*Laciniis* multo angustioribus et *valvulis indusii* integerrimis.

Ab. *H. bivalvi* situ fructificationum etc.—SWARTZ, Synopsis 378.

Fronds commonly 6 to 10, but sometimes up to 20 cm long, usually broadly ovate with broad base, glabrous or nearly so, rachis narrowly winged, the wing sparsely serrated with conspicuous teeth, large fronds quadripinnatifid, the segments linear, about 0.7 mm wide, the lamina usually not widened in the axils, serrate with prominent, rather remote teeth; cell walls uniformly thin and straight; sori on very short axillary segments, or terminal in very full fruit, involucre about 3 mm long, 1 to 1.5 mm wide, cleft about one-third (rarely, one-half) of the way down, the tube marginate on the sides, the lips wider than the tube and widening upward or less commonly narrowed, the lip entire or rarely with one or two irregular teeth. The plant bears faintly the odor of *H. sanguinolentum.*

Hooker, Sp. Fil. 98, notes a variety, B, on rocks, with "fronds scarcely an inch long." He also says "lips entire or serrated." I discuss under *H. revolutum* a dwarf with toothed lips, which, having also broad and short segments, looks to me more like that species, although mixed with small *H. multifidum.* The reductions of Colenso's species are made by Cheeseman, and tacitly accepted by Holloway, Trans. N. Z. Inst. 54 (1923), whose plate 69 illustrates the plasticity of the species.

NEW ZEALAND, many collections. A specimen from Lord Howe Island, *Watts,* in Queensland Herb., seems to be identical. Specimens bearing this name from many other islands seem to me all to be distinct. One from Samoa is sterile and might be this species, but is more likely to be *H. feejeense.* Also, from Aneityum, *Kajewski 871A,* sterile, is possibly *H. multifidum.*

44. HYMENOPHYLLUM BIVALVE (Forster) Swartz. Plate 30, figs. 4 to 6.

Hymenophyllum bivalve (Forster) SWARTZ, Schrad. Journ. 1800[2] (1801) 99 (not seen), Synopsis 146, 372; SCHKUKR, Krypt. Gew. 132, *pl. 135, b;* HOOKER, Sp. Fil. 1: 98, *pl. 35, D.*

Trichomanes bivalve FORSTER, Prodromus (1786) 84.

Sphaerocionium bivalve PRESL, Hymen. 126.

Trichomanes pacificum HEDWIG, Fil. (1803) (not seen).

Hymenophyllum spathulatum COLENSO, Tasm. Journ. 2 (1844) 184.

Hymenophyllum pyriforme VAN DEN BOSCH, Ned. Kruid. 5[8] (1863) 173.

T. biualue, frondibus subbipinnatis: pinnis alternis decurrentibus dichotomis, segmentis linearibus serratis, fructificationibus subrotundis biualuibus. F.—FORSTER, loc. cit.

Stipes semispithameus, filiformis, teres rigidus, fuscus, nigricans.

Frons oblonga, acuminata 2-pinnata glabra, sicca circinalis, recens subdiaphana quasi a vesiculis distinctis pellucidis conflata.

Rachis flexuosa, marginato-alata.

Pinnae alternae, ovato-acuminatae, decurrentes dichotomae.

Pinnulae lineares, obtusae denticulato-serratae.

Sori ad apices pinnularum solitarii globosi. *Columella* conico-cylindracea, exserta.

Indusia ovato—1. subrotundo-ventricosa, valvulis integerrimis conniventibus, pinnulae cui insident latiora.

Observatio. Laciniis s. pinnulis denticulato-serratis ab *H. clavato* facile distinguitur.—SWARTZ, Synopsis 372.

Very much like *H. multifidum.* The proposed distinctions are—

1. That *H. bivalve* is "subbipinnate," *H. multifidum* more compound; if this distinction holds, practically all specimens called *H. bivalve* are misnamed.

2. That the receptacle of *H. bivalve* is exserted; it is rarely so.

3. That the sori of *H. bivalve* are terminal, those of *H. multifidum* supra-axillary.

4. That the sori of *H. bivalve* are roundish, those of *H. multifidum* more elongate.

If the specimens in hand are correctly named, and if I understand the species—which may not be so, as I have not seen a *Forster* specimen—*H. bivalve* has uniformly roundish involucres, 1.5 to 1.8 mm long, which are "terminal," not on pinnæ, but on segments, usually remote from the margin of the frond and not much shorter than the adjacent sterile ones, while those of *H. multifidum* are larger and longer, and borne on much shortened segments. The fronds as a whole are so alike that I do not illustrate that of *H. bivalve*. It has the odor of other New Zealand species.

Specimens: NEW ZEALAND, *Kirk 560, Cheeseman 303, Sledge 345, Thomson, Green, Tryon, Setchell, Holloway, Hooker.* AUSTRALIA, New South Wales, *Baüerlen*: Queensland, Roberts Plateau, *Shirley.*

The Philippine plant given this name by J. Smith, *Cuming 264*, is *H. Meyenianum*. In the Hooker collections, *H. bivalve* and *H. multifidum* may have been confused; at any rate, as to sterile ones bearing both names, I cannot guess which is correct.

Hymenophyllum pyriforme was described with "parietibus incrassatis hyalinis pulchre regulariter crenulatis;" while *H. bivalve* should have them "rubellis diaphanis spinuloso-dentatis." The distinction is verbal, the two expressions denoting different manifestation of the same type of thickening. The unpublished sketches of van den Bosch show perfectly smooth and straight walls, and the crenate or toothed walls, for both species. The distinction between perfectly even walls, and the crenate-thickened or toothed walls, is usually specific, at least if it characterizes whole fronds. Of the specimens cited, half have the walls completely undifferentiated, and half have them typically thickened.

45. HYMENOPHYLLUM TRIANGULARE Baker.

Hymenophyllum triangulare BAKER, Syn. Fil. (1867) 69; Hooker's Ic. Pl., 1613.

H. mannianum KUHN, Fil. Afric. (1868) 40.

St. 2–4 in. l., smooth, naked; *fr.* ovate-triangular, tripinnatifid, 4–6 in. l., 2–3 in. br. at the base; *main rachis* winged above; the *second rachis* broadly winged throughout; *pinnae* rhomboidal-lanceolate; *lowest pinnl.* deeply pinnatifid, with simple or forked conspicuously spinuloso-dentate linear *segm.*, 2–3 in. l.; *sori* usually solitary, placed on the upper pinnae

at the base of the anterior pinnule at the outer side; *invol.* large, ovate, fully a line deep, divided about halfway down; *valves* nearly entire. H. Mannianum, *Mett.*

Hab. Fernando Po, *Mann*, 333.—Much resembling *H. multifidum* and *bivalve* in habit, but the segments are broader, and the sori are much larger and usually solitary. It is the only *Leptocionium* which has yet been found in Tropical Africa.—BAKER, Syn. Fil. 2d ed. 69.

Hymenophyllum mannianum is a name published a year later based on the same collection. I have not seen this collection, but the species seems to be represented by three collections from Kamerun: *Zenker 3879, Staudt 43,* and *Gocker 140,* all in U. S. Nat. Herb.

The wing on the rachises bears long, spinelike teeth. The internal walls are not clearly visible in middle optical section, and are therefore presumed to be thick and pitted; coming to the surface, they are crenulate, thickened, and toothed, similarly to *H. edentulum;* not many sori are present, and I have been able to detect just one protruded receptacle.

The deltoid fronds on long, very slender stipes make this species as distinct in appearance as it is geographically.

2. Subgenus AMPHIPTERUM Presl

Amphipterum PRESL, Epim. (1852) 258, *nomen,* as genus.

Altior evolutionis gradus est ille, si raches costaeque venaeque ala foliacea libera bilaterali serrata in pagina superiori frondis instructae sunt.—Talem organisationem exhibet inter Trichomanoideas Amphipterum fuscum (Trichomanes fuscum Blume, . . .).—PRESL, loc. cit.

Frondibus pinnatim decompositis, rhachi hirsuta, venis aut inferne aut utraque facie alatis vel cristatis; margine aut serrulata aut integra; soris magnis segmenta axillaria abbreviata tertiaria (vel sursum secondaria) terminantibus, involucro vix ad mediam longitudinem bilabiato, deorsum cristato vel laminato, receptaculo valde extruso.

Nearly related to *Meringium.* I would not consider it expedient to distinguish it generically or otherwise if the wings on the veins were the only distinction; but *A. fuscum* is no less peculiar in its combination of cristate involucre and entire margin. Accessory laminar outgrowths of the axis are known in several American species which I regard as phyletically remote; but in the case of *A. laminatum* and *A. geluense* I believe this common structural feature is evidence of real affinity. While I would not regard these outgrowths as a very sufficient generic character, they serve well for the recognition of the group. Van den Bosch, Hymen. Javan. 64, was disposed to agree with Presl

on the generic distinctness of his *H. fuscum*, but would have placed it in Didymoglosseæ. In drying, the frond curls downward, but the sides of the segments are raised, in the manner familiar in *Gonocormus*.

Four species. Range: Sumatra to New Guinea.

Key to the species of the subgenus Amphipterum.

Margin entire.
  Nether surface lamellate .... 46. *H. fuscum.*
  Both surfaces lamellate .... 47. *H. Ledermanni.*
Margin serrulate: both surfaces lamellate.
  Rachis stout, hirsute .... 48. *H. geluense.*
  Rachis slender, glabrescent .... 49. *H. laminatum.*

46. HYMENOPHYLLUM FUSCUM van der Bosch. Plate 31.

Hymenophyllum fuscum VAN DEN BOSCH, Hymen. Javan. (1861) 62, *pl. 51, 52 B.*

Trichomanes fuscum BLUME, Enum. (1828) 225.

Amphipterum fuscum PRESL, Epim. Bot. (1852) 258.

Didymoglossum fuscum HASSKARL, Fil. Javan. 2 (1857) 19.

Hymenophyllum dipteroneuron A. Br.: KUNZE, Bot. Zeit. 5 (1847) 225.

Hymenophyllum zollingerianum KUNZE, Bot. Zeit. 6 (1848) 305; VAN DEN BOSCH, Hymen. Javan. 61, *pl. 50, 52 A.*

Didymoglossum zollingerianum HASSKARL, Fil. Javan. 2 (1857) 20.

T. fronde pinnata lanceolata diaphana, pinnis alternis subsessilibus (superioribus adnatis) ovalibus obtusis basi truncatis lobato-pinnatifidis ad costam utrinque paleaceo-hirsutis, lobis incisis, rachi superne marginata stipiteque teretiusculo ferugineo-hirtis.

Crescit in Javae montibus excelsis.—BLUME, loc. cit.

Van den Bosch distinguished *H. fuscum* from *H. Zollingerianum* by "habitus minus laxus, rhachis, excepta basi, manifeste alata, laciniae minores lacinulaeque angustiores, cristae membranaceae ubique in fronde valde conspicuae latae, contextus laxior e cellulis majoribus minus opacis undulatis, etc." He expressed doubt as to the constancy of these criteria; Hasskarl, op. cit. 20, questioned the specific distinctness; the Synopsis Filicum ignored *fuscum* under whatever genus; and Raciborski, Flora v. Buitenzorg, ignored *H. Zollingerianum.* I do not find any character by which any line can be drawn between the two; nor do the several differences between the extremes constitute a cumulative difference, because they are correlated, all alike presumably affected by the same external conditions. I have collected on the Gedeh the extremes, together, even on the same rhizome (Plate 31, fig. 1).

The fronds of typical *H. fuscum* are broadly lanceolate to ovate, 6 to 15 cm long, acute and compact. From this they

vary to narrowly lanceolate with remote pinnæ and attenuate apex, and up to 35 cm long, in which form it is typical *H. Zollingerianum.* I suppose that the elongate, lax form develops in moist, sheltered places.

The rachis is more narrowly winged (it is never very broad) in the elongate form, and on well-developed fronds is always wingless at the base. The upper part of it bears the supplementary wings on the nether side (cf. Blume's *superne*). Partly in continuation of the supplementary wings, the base of the involucre bears several similar longitudinal wings, extending almost as far as the tube.

The species seems to be common in Java, at least West Java, from which I have seen type material of all described species. A considerable part of the more recent collections, correctly placed under *H. fuscum* in the Leyden Herbarium, are typical *H. Zollingerianum.* I have seen a single specimen from Sumatra, *Rosenstock Fil. Sumatra. exsicc. 210, Winkler.* An older Sumatra collection was misidentified; it is a sterile fragment of some other species.

The walls of *H. fuscum,* correctly depicted by van den Bosch taking together his drawings of *H. fuscum* and *H. Zollingerianum,* are thin, straight or slightly wavy in median optical section, nearly straight or minutely wavy where they strike the surface walls, and toothless or somewhat toothed there. The more evident reticulation and toothing of *H. geluense* and *H. laminatum* is indicated, but very slightly developed.

47. HYMENOPHYLLUM LEDERMANNI Brause. Plate 32.

Hymenophyllum Ledermanni BRAUSE, Bot. Jahrb. 56 (1920) 41.

Rhizoma longe repens, 0,8 mm crassum, glabrescens, juventute pilis ferrugineis articulatis densis munitum, folia interstitiis 2–4,5 cm longis emittens. Petioli fusci, teretes, rigidi, superiore in parte angustissime alati, rhizomati similes glabrescentes vel pilosi, 7–13 cm longi, 1 mm crassi. Lamina 10–15 cm longa, 2,5–7 cm lata, sicca fusca, glabra, ambitu lanceolata vel ovata, in apicem obtusiusculum desinens, pinnato-bipinnatifida vel bipinnato-pinnatifida; pinnis I petiolatis, 10–14-jugis, approximatis, alternis, suberecto-patentibus e basi cuneata rhomboideo-oblongis, apice truncatis, usque ad 3 cm longis, 1,7 cm latis; pinnis II e basi cuneata ovatis vel rhomboideis, obliquis, approximatis, apice truncatis, usque ad costulam fere pinnatifidis; segmentis linearibus vel subquadrangularibus, fasciculatim subparellelis, confertis, margine integris; rachibus costisque fuscis, anguste alatis, pilis longis, ferrugineis, articulatis curvatis densis instructis; costis nervisque validis, fusco-pilosis, utrinque lamellis membranaceis praeditis. Sori superiorem dimidiam laminae partem occupantes,

axillares, nervorum ramo infimo antico abbreviato impositi, pinnis II basilaribus interdum 2 soros gerentibus exceptis singuli in pinnis II, usque ad 8 in pinnis I, uniseriales in utroque costae latere, ca. 2,5 mm longi, 1 mm lati, angustissime marginati, indusio cupuliformi, ore vix dilatato, dorso nervis aequali lamellis densis prominentibus armato, bilabiato; labiis apice rotundatis, laevibus (non lamellis praeditis), membranaceis; receptaculo crasso, brunneo, usque ad 0,5 mm exserto.

Nordöstl. Neu-Guinea: Kaiserin-Augusta-Fluss-(Sepik) Gebiet: Etappenberg, dichter Höhenwald, hell grünes Hymenoph., epiphytisch in einer Baumkronc, 850 m ü. M. (Ledermann n. 9408.—21. Okt. 1912),—ebendort, 10–15 cm hohes Hymenoph. im Moospolster der Bäume (Ledermann n. 8993.—3. Okt. 1912).

Gehört zu den Arten, bei denen die Kosta und Nerven mit zweiflügeligen Leisten versehen sind, wie bei *H. fuscum* Bl. und *H. geluense* Ros. Letzteres ähnelt der vorliegenden Art im Habitus sehr, auch in dem trichomanoiden Indusium, aber es hat gezähnten Blatt- und Leistenrand, weiter auseinander gestellte Nerven und breitere letzte Fiederabschnitte. Bei der vorliegenden Art Bestehn die Fiedern II hauptsächlich aus den durch die Leisten noch dicker erscheinenden Nerven, an deren beiden Seiten die Blattfläche auf das äusserste beschränkt ist.

Die Art scheint in der Form und Länge der Fiedern sehr veränderlich zu sein. Es liegen etwas 35 an derselben Stelle gesammelte Blätter vor, von diesen ist kaum eines dem anderen gleich. Die Fiedern I werden bis 5 cm lang und sind am Scheitel nicht gestutzt, sondern im Gegentiel lang zugespitzt; Fiedern II werden schmäler, zahlreicher und spitzer; letzte Fiederabschnitte noch schmäler. Die äusserste Form dieser Abweichungen möchte ich bezeichnen als:

Var. NUTANS Brause n. var.—Differt laminis nutantibus, pinnis longioribus, longissime acuminatis, pinnis II angustioribus, numerosioribus, acuminatis; laciniis angustioribus.

Nordöstl.-Neu-Guinea: Kaiserin-Augusta-Fluss- (Sepik-) Gebiet: Lordberg, lichter Bergwald, bräunlich-hell-grünes Hymenoph., Behaarung dunkelbraun, in den grossen Moospolstern der Baumkronen, 2000 m ü. M. (LEDERMANN n. 10117.—6. Dez. 1912),—Etappenberg, 850 m ü. M. (LEDERMANN n. 9171a.—11. Okt. 1912).

I am indebted to the courtesy of the Berlin Botanic Garden for a partial frond of the type collection, *Ledermann 9408*. It is nearer to *H. fuscum* than to the related Papuan species, as shown by the entire margins and by the cellular structure. The most of the walls are almost uniformly thin, but crenulate or slightly toothed walls can be detected here and there. The frond is the most compacted in the group, the veins in the uncut central parts of the pinnæ and pinnules running parallel and so close together that the secondary wings are in many places in contact, concealing the normal lamina.

The variety is probably not one, but merely an edaphic form like *H. Zollingerianum*.

47a. HYMENOPHYLLUM CERNUUM Gepp.

Hymenophyllum cernuum GEPP, in Gibbs, Dutch N. W. New Guinea (1917) 68.

I have not seen this plant. By description, it seems to resemble a slender form of *H. Ledermanni.*

48. HYMENOPHYLLUM GELUENSE Rosenstock. Plate 33.

Hymenophyllum geluense ROSENSTOCK, Fedde's Repert. 5 (1908) 372.

Leptocionium; rhizomate longe repente, vix ramoso, 1 mm crasso, rufo pilisque rufis dense obsito, radiculis 2–3 cm longis, creberrimis instructo, interstitiis 5–15-centimetralibus folia gerente; stipitibus 10–20 cm longis, rigidis, teretibus, atrofuscis, pilis fuscidulis 2–3 mm longis, tricatis obtectis; laminis rigide membranaceis, fuscidulis, 20–30 cm longis, nunc linearibus, 2–3 cm latis, nunc lanceolatis, basi usque ad 8 cm dilatata; illis pinnatis, pinnis alternis, numerosissimis, erecto-patentibus, apice incurvatis, anguste decurrentibus, e basi inaequali (anteriore cum rhachi parallela, posteriore oblique truncata) rhomboideo-oblongis, apice truncatis aut elongato-acuminatis, 1½–3 cm longis, 1 cm latis, 2–3-pinnatifidis, laciniis ultimis anguste linearibus, confertis, fasciculatim subparallelis, margine plano acute serratis, apice attenuato integerrimis (nec emarginatis); his (sc. laminis lanceolatis) bipinnatis, pinnis inferioribus usque ad 10 cm longis, 3–4 cm latis, faciem laminae simpliciter pinnatae omnino interantibus, ceteris sensim minoribus, subconformibus; rhacibus cum stipitibus concoloribus, elasticis, margine angusto, olivaceo-fusco, plano, integerrimo vel (apicem versus) denticulato pilisque iis stipitum aequalibus instructis; costis nervisque crassis, atrofuscis, fuscopilosis, in utraque facie lamellis binis membranaceis, conspicue cristato-serratis ornatis; soris 1–4 in singulis pinnulis, axillaribus, costularum ramo anteriori, abbreviato impositis; indusiis magnis, late tubiformibus, anguste marginatis, dorso cristatis, bilabiatis; labiis tubum aequantibus, rotundatis, minutissime denticulatis vel integerrimis; receptaculo crasso, setaceo, exserto.

Nova-Guinea, in monte Gelu, c. 1000 m alt.—leg. Dr. E. Werner, VII, 1907, No. 48.—ROSENSTOCK, loc. cit.

I know, and have illustrated, this species by a subsequent collection, *Rosenstock, Fil. novoguin, exsicc. 178, Bamler,* Sattelberg, altitude 900 m. This is represented in the Phil. Nat. Herb., the Gray Herb., and particularly well in the Herb. Univ. Calif. Collectively these illustrate fairly the described range in size and dissection.

The cells are slightly elongate; internal walls broadly and shallowly reticulate-pitted, finely wavy where they impinge against the surface walls and there conspicuously toothed by thickened lines on the superficial walls.

49. HYMENOPHYLLUM LAMINATUM Copeland. Plate 34.

Hymenophyllum laminatum COPELAND, Philip. Journ. Sci. § C 6 (1911) 70.

Rhizomate repente pube purpurea vestito; stipite 4 ad 5 cm alto sursum pubescente; fronde ca. 15 cm alta, 2.5 ad 3.5 cm lata, lanceolata, rhachi anguste 2–4 alata; pinnis lanceolatis, acutis, inferioribus brevistipitatis, fere ad costam pinnatisectis; segmentis oblanceolatis vel obovatis, apice incisis sparse serrulatis, tenuiter rigidis, rufis; venis venulisque late et usque ad marginem undulato-cristatis; soris secus rhachin ordinatis, basi cristatis, ore bifido, laciniis denticulatis.

[King] No. 341, Lakekamu. [Papua.]

Nearest *H. fuscum* (Blume) v. d. Bosch, differing from this relative in the narrower pinae, more prolonged lamellae, occasionally serrate margin and denticulate lobes of the indusium.—COPELAND, loc. cit.

The cells of the normal lamina are somewhat elongate. The internal walls are broadly and shallowly pitted (reticulate), and nearly straight or finely wavy where they meet the superficial walls. Along these lines, there are outgrowths (teeth). The degree of the thickening which forms the pits and teeth is very variable on different parts of the one known specimen.

In publishing this, I overlooked the then recently described *H. geluense*. Judging by the single collections *H. laminatum* seems very well and conveniently distinguished by the much less hairy and more slender stipe and rachis. Also the secondary lamination is more continuous, firmer, and less toothed, and the involucre less cristate.

3. Subgenus MYRIODON novum

Lamina normale continua omnino carente, dentibus longitudinalibus ad rhaches costasque ubique et irregulariter affixis substituto, involucro medio fisso ubique dentifero, receptaculo extruso.

One species, endemic in New Guinea. Apparently a very specialized derivative of *H. denticulatum*.

50. HYMENOPHYLLUM ODONTOPHYLLUM Copeland sp. nov. Plate 35.

Rhizomate 0.3 mm crasso, glabrescente; stipite 1.5 ad 4 mm alto, filiforme, tereto; fronde usque ad 8 cm longa, vix 2 cm lata, bi-tripinnata, pinnis et pinnulis adscendentibus sursum dense imbricatis, rhachibus "costisque" ubique dentibus longitudinalibus heterostiche insertis, basibus elongatis deinde valde attenuatis, apicibus filiformibus saepe fuscescentibus, densissime obsitis, lamina frondis aliter carente; cellulis plerisque elongatis,

parietibus marginalium denticulis incurrentibus ornatis, internalibus rectis vix incrassatis, apud superficiem plerumque inconspicue irregulariter incrassatis; soris supraaxillaribus, sessilibus, involucro ca. 2 mm longo, 1.5 mm lato, ubique densissime dentifero, receptaculo longissime exserto.

NEW GUINEA, "Kaiserin-Augusta-Fluss-(Sepik-) Gebiet: Felsspitze—in Baumkronen," altitude 1,400 to 1,500 m. *Ledermann 13057*. Type in Herb. Univ. Calif.

This is *H. sabinifolium* var. *imbricata* Brause, Engler's Bot. Jahrb. 56 (1920) 45. I have no doubt that *H. sabinifolium* var. *irregularis* Brause, ibidem, is the same. But it is not *H. acanthoides* (*H. sabinifolium*), and I am not sure that they are intimately related. That species has all axes, from stipe to veins, bearing on each side a continuous wing, such as regularly constitutes the lamina in this family, the wing being exceedingly overfull and therefore ruffled (crisped), with the result that the very numerous large marginal teeth stand out in all directions. *Hymenophyllum odontophyllum* bears no continuous wings. Instead, with increasing density from the base of the rachis to the lips of the pinnules, the axes are beset with individual, separate teeth, the few basal ones in the position of a discontinuous but otherwise normal lamina, but elsewhere apparently erect from any line on the periphery of the axes. They are so densely placed, and so imbricate, that the bases become hidden; where they are least dense, I have thought that they might be in six or eight rows. They might represent the supplementary and normal laminæ of *Amphipterum*, but I have no evidence except their place of origin to support this suggestion.

4. Subgenus HEMICYATHEON Domin

Hemicyatheon DOMIN, Bibl. Bot. 20 Heft. 85 (1915) 20.

Pinnulis (segmentis) ultimis integris vel spinuloso-denticulatis; indusiis infundibuliformibus parte inferiore connatis sed supra profunde (usque ad medium vel duas partes tertias) bilabiatis et campanulato-patentibus; receptaculo longe exserto.—DOMIN, loc. cit.

A group of two known species, typified by *H. Baileyanum*, with entire margin. The second species, with serrate margin, is neither *H. praetervisum* nor the Australian plant, *H. pseudotunbridgense*, placed here by Domin, but is *H. Deplanchei*, of New Caledonia. As the chief reason for recognizing this group as an entity is its containing species with both kinds of margin, it is an amusing coincidence that such a pair of species actually exists. Unless the group be recognized as such, either its two

members must be widely separated, contrary to nature, or it must be included in *Meringium*, where *H. Baileyanum* would be very much out of place, or in *Mecodium*, where *H. Deplanchei* would be altogether misplaced.

I have already shown that the occurrence of such a group as this is explicable by assuming hybridization between members of the two great groups the characters of which are here combined.

Key to the species of the subgenus Hemicyatheon.

Margin toothed .... 52. *H. Deplanchei.*
Margn entire .... 51. *H. Baileyanum.*

51. HYMENOPHYLLUM BAILEYANUM Domin. Plate 36.

Hymenophyllum Baileyanum DOMIN, Bibl. Bot. 20 Heft 85 (1913) 21, *pl. 2, figs. 2, 3.*

H. trichomanoides F. M. Bail. Rep. Gov. Sci. Exped. Bell.-Ker Range 74 (1889), 3rd Suppl. Syn. Queensl. Fl. 90 cum tab. (1890), Catal. Plants Queensl. 58 (1890), Lithogr. Ferns Queensl. tab. 31 (1892), Queensl. Fl. VI. 1946 (1902), non v. d. Bosch 1863.

Rhizomate longissime repente saepe ½ m vel usque 1 m longo tenui filiformi fusco paleis piliformibus adpressis sed apice recurvis sat dense obtecto vel rhizomatibus vetustis interdum subnudis; frondibus sparsis distantibus stipitatis, stipitibus gracilibus nudis exalatis circa 15–20 mm longis; lamina in circuitu ovato-oblonga ovato-lanceolata usque fere lanceolata apice interdum attenuato-elongata circa 5–8 cm longa et 3½–4½ cm lata utrinque glabra pellucida; rhachi tenuiter sed conspicue alata, ala circa ⅓ mm lata plana; lamina bipinnata, pinnis densiusculis planis flabellato-pinnatifidis, pinnulis ultimis valde obtusis linearibus circa 1¼–1¾ mm latis integerrimis; venis dichotomo-flabellatis fuscis prominulis; soris in venulis lateralibus terminalibus in laminae parte superiore sat numerosis segmentorum apice insertis; indusio basi segmento immersa infundibuliformi sed apice libero (indusii totius dimidium vel usque fere duas partes tertias exhibente) bilabiato, labiis late oblongis integris obtusis glabris demum subpatentibus; receptaculo prima juventute incluso demum longe (usque 3 vel interdum quoque 4 mm) exserto.

Endemisch auf dem höchsten Rücken des Bellenden-Ker, auf Bäumen und Sträuchern epiphytisch wachsend (Bailey 1889, DOMIN I. 1910 auf dem mittleren Gipfel).

Eine sehr merkwürdige Pflanze, die einigermassen zwischen *Trichomanes* und *Hymenophyllum* steht. Schon BAILEY sagt: "Indeed it may be placed in either *Trichomanes* or *Hymenophyllum;* I place it in the latter because the whole of the exserted portion of the indusium consists of the two long obtuse lobes."—DOMIN, loc. cit.

Through the kindness of Mr. C. T. White I have been able to study the ample type collection of this species. Domin's description is excellent. The frond is thin, even for *Hymenophyllum.* The walls are glasslike in transparency, vanishing in too strong light; they are slightly thickened, minutely irregularly thickened

or minutely crenulate (as to the sides, not as to the walls as a whole).

On this species, Domin, op. cit. 20, based a new subgenus, *Hemicyatheon.*

As diagnosed, this would include *H. holochilum* and the difficult group of *H. edentulum,* to which I do not believe that *H. Baileyanum* has any near affinity. It is distinct in texture, nakedness, and wall structure. Neither do I relate it to *H. praetervisum.*

The involucre is of too general a type to be significant. However, aside from *H. macroglossum* and a few relatives with thick, toothed walls, the combination of entire margin, half-cleft involucre, and long receptacle is peculiar enough to justify Domin's subgenus.

52. HYMENOPHYLLUM DEPLANCHEI Mettenius. Plate 36.

Hymenophyllum Deplanchei METTENIUS, Linnaea 35 (1868) 393.

Rhizoma ultra setaceum, paleaceo-setosum; folia membranacea, firma, flavo s. olivaceo-viridia, glaberrima, tri-subquadripinnati-partita; petiolus 2" longus e basi cum rhachi anguste alatus; lamina 3½" longa, deltoidea; laciniae primariae approximatae s. imbricatae, patentissimae, brevi petiolulatae trapezio-oblongo-lanceolatae, infimae suboppositae, ovato-lanceolatae, secundariae ala latiore siccatate recurva confluentes, trapezio-oblongae, obtusae, tertiariae late crenatae, bi-trifidae, superiores et ultimae oblongae s. elongato-oblongae, obtusae repande s. obtuse serratae, hinc inde ad latera subintegerrima antice dente una altiore praeditae; sori in dimidio superiore laminae lacinulas anticas infimas s. inferiores paullulum abbreviatas occupantes, basi cuneati immersi; labia indusii tubum aequantia, semi-oblonga, obtusissima, integerrima s. obscure repandula; receptaculum inclusum; paraphyses nullae.

Nova Caledonia; sur les arbres; au pic de la montagne de Mu. 1864 (Deplanche n. 174).

Petiolo anguste alato ab *Hym. multifido* Sw. et *bivalvi* Sw. recedens, sororum numero ac dispositione cum posteriore, indusii magnitudine cum priore congruens, habitu ceterum *Hym. sanguinolento* non absimile.

—METTENIUS, loc. cit.

Rhizome 0.5 to 1.0 mm in diameter, wiry; stipe about equally stout, 5 to 10 cm long, dark, with a narrow green wing nearly to the base; frond 8 to 20 cm long, broadly ovate, acuminate with apex usually curved, clear-green, tri- or quadripinnatifid, axes everywhere winged, the wing toothed where not exceedingly narrow; segments crowded, about 0.8 mm wide with remote, prominent teeth; cells mostly isodiametric, internal walls clear, thin, straight, and even, fringed exactly where they strike the surface walls with close, short, thin, colorless teeth, not every-

where visible; sori numerous, on subobsolete supra-axillary segments, involucre about 2.5 mm long, 1 to 1.5 mm wide, cleft hardly halfway down, tube smooth, winged or not winged at base, lips pale, wide, broadly rounded, usually entire or nearly so, but sometimes distinctly toothed, receptacle usually but not always included.

Endemic in New Caledonia.

Specimens: *Balansa 2706a, Cribs 1343, LeRat 843, 874, Schlechter 14757* (as *H. dimidiatum*), *Franc 68bis, "F", 1394, 2257,* and *Rosenstock Fil. Novae Caled. 132.*

5. Subgenus EUHYMENOPHYLLUM

Hymenophyllum J. E. Smith, Mém. Acad. Turin 5 (1793) 418, genus, typified by *H. tunbridgense*, the only original species.

This subgenus is characterized by small fronds, toothed margins, cell walls little if at all differentiated, involucres cleft to the bottom or nearly so, slender receptacles included or hardly exceeding the lips, and sessile sporangia. It is not a large group, and is distinctly nontropical, reaching the latitudinal extremes of the family, north and south. *Hymenophyllum affine* and *H. perfissum* are the only local tropical species in the Old World, unless *H. bontocense* belongs here, and unless, as has been stated, it is represented in tropical Africa. *Hymenophyllum barbatum* and *H. simonsianum* have a range within the Tropics, but are better regarded as North Temperate Zone plants.

Many species have been described as relatives of *H. tunbridgense*, but the usual feature responsible for this is nothing more conclusive than smallness.

Key to the species of the subgenus Euhymenophyllum.

Axes not scaly.
- Lips of involucre entire or essentially so.
  - Frond more than 2 cm long.
    - Rachis of well-developed plants wingless at base.
      - Sori sessile. (Australia, Norway, etc.) 53. *H. peltatum.*
      - Sori slightly immersed. (Fiji.) .... 54. *H. affine.*
      - Sori stalked.
        - Segments 1.5 mm wide. (Borneo.) 55. *H. perfissum.*
        - Segments 0.5 mm wide. (Australia.) 58. *H. gracilescens.*
    - Rachis winged throughout. (Australia.) 56. *H. antarcticum.*
  - Frond under 15 mm long. (New Zealand.) .... 57. *H. Cheesemanii.*

Lips of involucre toothed.
Frond more than 2 cm long.
Rachis winged throughout.
Segments 0.5 mm wide. (Australia.) 58. *H. gracilescens.*
Segments 1 mm wide.
Segments serrulate. (South Africa; Europe.) 59. *H. tunbridgense.*
Segments spinulose-dentate. (Asia.) 60. *H. barbatum.*
Segments 2 mm wide. (India to Formosa.) 61. *H. simonsianum.*
Rachis terete toward base.
Marginal teeth falcate. (New Zealand.) 62. *H. revolutum.*
Marginal teeth straight. (Australia.) 63. *H. cupressiforme.*
Frond under 2 cm long.
Involucre shallowly cleft.
Marginal teeth conspicuous. (New Zealand.) 62. *H. revolutum.*
Marginal teeth small. (Australia.) .... 64. *H. pumilum.*
Involucre deeply cleft. (New Caledonia.) .... 65. *H. pumilio.*
Axes scaly and hairy. (Sikkim, Himalaya.) .... 66. *H. Levingii.*

53. HYMENOPHYLLUM PELTATUM Desvaux. Plate 37.

Hymenophyllum peltatum DESVAUX, Prod. (1827) 333.
Trichomanes peltatum POIRET, in Lam., Encyc. 8 (1808) 76.
Hymenophyllum unilaterale WILLDENOW, Sp. Pl. 5 (1810) 521.
Hymenophyllum Wilsoni HOOKER, Brit. Fl. I (1830) 446; WILSON, Suppl. to Engl. Bot. pl. 2686.
Hymenophyllum Meyeri PRESL, Hymen. (1843) 142.
Hymenophyllum tunbridgense SCHKUHR, Krypt. Gew. *pl. 135, d, non* Smith.

The descriptions by Poiret and Willdenow were both based on a collection by Bory in Bourbon, and Poiret's is so poor that I present Willdenow's.

H. frondibus pinnatis, pinnis digitato-pinnatifidis secundis, laciniis linearibus subbifidis serratis, soris supraaxillaribus solitaris, indusiis integerrimis, rachi stipiteque teretibus glabris. W.

H. frondibus pinnatis linearibus, pinnulis cuneiformibus dentatis, interne laciniatis et soriferis. Bory in litt.

Einseitiger Hautfarrn. W.

Habitat in insulae Borboniae montibus mille orgyas supra mare elevatis, ad rupes humidas. 4 (v. s.)

Caudex repens filiformis crassitie capilli. Stipes pollicaris capillaris teres glaber. Frons sesqui- vel bipollicaris pinnata, circumscriptione lineari-lanceolata. Pinnae inferiores et superiores minores intermediae tri- vel quadrilineares digitato-pinnatifidae glabrae secundae. Laciniae lineares

indivisae vel bifidae obtusiusculae serratae. Rachis teres glabra. Sori supraaxillares sessiles. Indusia oblonga obtusa integerrima. W.

—WILLDENOW, loc. cit.

The range is from Norway to France and Ireland, and around the globe in the South Temperate Zone.

It is nearly related to *H. tunbridgense,* from which it is critically distinguished by the entire lips of the involucre. In the British Isles, whence there are many specimens of both, this one has usually longer, narrower, and laxer fronds, longer and narrower segments, the wing of the rachis narrower or obsolete toward the base, and narrower involucre. It is so nearly the same in all parts of its range that there is little temptation to recognize local derived species.

The cell walls are uniformly thin, and the cylindrical receptacle is, at least usually, included.

53a. **HYMENOPHYLLUM THOMASSETII C. H. Wright.**

Hymenophyllum Thomassetii, C. H. WRIGHT, Kew Bull. (1906) 170.

Rhizoma repens, gracile. *Stipes* erectus, gracilis, glaber, circa 1 cm. longus. *Lamina* bipinnatisecta, 5 cm. longa, 2.5 cm. lata, glabra; segmenta linearia, 0.7 mm. lata, praesertim versus apices minutissime serrata; rhachis anguste alata. *Sori* quasi-axillares ad rhachin; involucrum breviter ovatum, integrum vel minutissime dentatum.

BRITISH CENTRAL AFRICA. Mount Mlanji, 2400 m., *Thomasset.*

Said to differ from *H. tunbridgense* in form of segments and in subentire involucres. As to both of these criteria, it might be *H. peltatum,* but I do not care to reduce it without seeing a specimen.

54. **HYMENOPHYLLUM AFFINE Brackenridge. Plate 38.**

Hymenophyllum affine BRACKENRIDGE, U. S. Expl. Exped. 16 (1854) 265, *pl. 37, fig. 1, a, b, c;* VAN DEN BOSCH, Ned. Kruid. Arch. 5^3 (1863) 171.

Hymenophyllum tunbridgense var. *exsertum* BAILEY, Rep. Exp. Bellenden-Ker (1889) 74; Lith. Queensland Ferns, *pl. 30.*

Hymenophyllum praetervisum var. *australiense* DOMIN, Bibl. Bot. 20 Heft 85 (1913) 21.

Hymenophyllum pseudotunbridgense WATTS, Proc. Linn. Soc. New South Wales 39 (1915) 766.

H. rhizomate filiforme repente; stipitibus brevibus tenuibus parce villosis; frondibus parvis membranaceis late ovatis bipinnatifidis; pinnis imbricato-confertis subflabellatis, laciniis lineari-oblongis obtusis simplicibus vel bifidis spinuloso-serratis; indusio supra-axillari obovato basi subimmerso infra medium usque bivalvi, labiis integerrimis; receptaculo brevi incluso.

Hab. Ovolau, Feejee Islands: on rocks.

Rootstock long, *filiform,* and creeping. *Stipes* about half an inch in length, very *slender, terete, sparingly villous. Fronds bipinnatifid,* from

half an inch in length, *membranaceous, broad-ovate* or ovate in circumscription, with *imbricated and somewhat subflabelliform pinnae;* the *laciniae linear-oblong, obtuse* and *simple,* or oblong and *bifid,* the margin *spinulose-serrate.* Sori few on the upper half of the fronds; the *indusium supra-axillary, obovate,* plane, and *two-valved* for fully two-thirds of its length, the margin of the *lips entire,* the base only *slightly immersed* in a short segment. *Receptacle short included.*

This is related to the *H. Tunbridgense;* from which it is distinguished by the shorter stipe, the broader fronds, the crowded and imbricated pinnae and particularly by its obovate, deeply divided, entire-lipped indusium. In the latter respect it resembles more the *H. Wilsoni,* but the indusium is not inflated at the base as in that species; the form of the fronds and direction of the pinnae are also very different.—BRACKENRIDGE, loc. cit.

The type in the United States National Herbarium is as described, with very small fronds cut nowhere to the rachis. *Parks 20040,* collected from the trunk of mangrove trees in Suva Harbor, matches the type with its smaller fronds, but has others 3 cm long and narrower in outline, which are completely pinnate at the base, with terete rachis above the lowest pinnæ.

Instead of a "species caeterum egregie distincta" (van den Bosch), it seems to me to be rather a local derivative of *H. antarcticum* or its group (*H. peltatum*), with rather broader segments and some pubescence on the axes.

Known to me by the two collections already cited in Fiji, and by two in Queensland, one the type collection of *H. tunbridgense* var. *exsertum.* A plant distributed with this name from Pahang (*13939*—probably a Singapore field number) is *H. edentulum,* or near it.

55. HYMENOPHYLLUM PERFISSUM Copeland. Plate 39.

Hymenophyllum perfissum COPELAND, Philip. Journ. Sci. § C 12 (1917) 47.

Leptocionium lamina plana, involucro fere ad basin fisso labiis integris; rhizomate filiforme, fusco-nigro, ramoso, nudo; stipite 10 ad 15 mm lato, glabro, filiforme; fronde ca. 4 cm alta, 10 ad 15 mm lata, glabra, pinnata, rhachi sursum anguste alata ala integra, deorsum vix marginata; pinnis majoribus subpinnatifidis segmentis 3 ad 5, minoribus furcatis, minimis simplicibus, segmentis ca. 4 mm longis, vix 1.5 mm latis, obtusis, serratis dentibus paucis subspiniformibus, fuscis vel fusco-olivaceis; soris segmenta abbreviata prima acroscopica pinnarum subapicalium occupantibus, receptaculo fusiforme incluso, involucro § ad basin fisso, labiis obovato-orbicularibus, integris, nudis, 1.5 mm longis.

BORNEO, Mount Kinabalu, altitude 3,700 meters, on tree trunks, *Mrs. Clemens 10588.*

Apparently a quite distinct little plant.—COPELAND, loc. cit.

Still known by the type collection only.

The only addition to the description is that the walls are uniformly thin.

Very distinct in its own area, but very close to *H. peltatum*, from which it is feebly distinguished by broader segments, and in general by narrower wings on the rachis.

56. HYMENOPHYLLUM ANTARCTICUM Presl. Plate 40.

Hymenophyllum antarcticum PRESL, Hymen. (1843) 142.
Hymenophyllum Babindae WATTS, Proc. Linn. Soc. New South Wales 39 (1915) 766, *pl. 87, fig. 5.*

H. glaberrimum, fronde oblonga obtusa bipinnata, pinnis subsessilibus oblongo-lanceolatis, pinnulis oblongo-lanceolatis obtusis sinuato-acuteque serrulatis decurrentibus, soris pedicellatis obovato-subglobosis, indusio integerrimo aut obsolete denticulato receptaculum aequante, stipite rachibusque alatis.

H. tunbridgense. Sieb. *syn. fil. n.* 134, *flora mixta n.* 254.

Habitat in Nova Hollandia ad Port Jackson, ubi legit Sieber.

Priori [*H. Meyeri*] et H. Wilsoni affine; ab H. Meyeri differt pinnis utrinque evolutis, pinnulis latioribus oblongo-subinde obovato-lanceolatis, rachibus stipiteque alatis, soris pedicellatis, indusio obovato-subgloboso, receptaculo indusii longitudine aut longiore.—Ab H. Wilsoni differt praecipue pinnis pinnulisque, soris, indusio et receptaculo.—PRESL, loc. cit.

A cotype, *Sieber. Syn. Fil. 134*, is *Herb. Lugd.-Bat. 908, 282–203*, and I have used it to illustrate this species, which has usually been construed as *H. tunbridgense.* With it I identify collections by Boorman from Beronera and Bateman's Bay, and by Gunn from Tasmania, ex Herb. Hooker as *H. unilaterale* and *H. tunbridgense.*

The rachis is narrowly winged throughout; the walls uniformly thin; the involucres very broad with crenate or obscurely toothed lips; the receptacle slightly extruded in many sori, not so in others.

I do not believe that this should be reduced to *H. tunbridgense*, but do suspect that, with any such number of collections as represent the commoner Malayan species, this might become inseparable from *H. cupressiforme.*

A cotype of *H. Babindae*, sent me by Mr. White from the Queensland Herbarium, seems to me to be a dwarf form of *H. antarcticum*, the fronds hardly 2 cm long.

57. HYMENOPHYLLUM CHEESEMANNI Baker. Plate 41.

Hymenophyllum Cheesemanni (*rite, Cheesemanii*) BAKER, in Hooker's Ic. III 2 (1873) 30, *pl. 1132*, Syn. Fil. (1874) 464.

Rhizomate nudo filiformi, stipitibus brevissimis filiformibus nudis, frondibus minimis dichotome furcatis vel palmatim 3–4-fidis raro simplicibus, lobis ligulatis obtusis ciliato-dentatis, venis in segmentis solitariis centralibus, soris solitariis terminalibus, involucri valvis rotundatis integris basi solum immersis.

Hab. New Zealand; Titiranga range, at an elevation of 1,200 feet, discovered by Mr. T. F. Cheesemann in 1871.

Rhizomata late vagantia intricata. *Stipites* segregati, erecti, 3–6 lin. longi, glabri, haud paleacei. *Lamina* viridis, membranacea, glabra, mox brunnescens, 3–6 lin. longa, basi in stipitem angustata, lobis 3–5 lin. latis ligulatis simplicibus, lateralibus erecto-patentibus. *Dentes* marginales lineari-subulatae, ascendentes, demum caducae, cellulae magnae irregulariter hexagonae marginales reliquis conformae, parenchymatosae. *Involucrum* vix lineam longum, semper ad apicem frondis vel segmentorum solitarium, terminale, valvis duris brunneis integerrimis lineato-marginatis dorso nudis laevibus.

A very distinct novelty, nearest *H. minimum,* A. Rich, 'Voy. Astrolabe,' t. 14, fig. 2; but differing essentially in the involucre, and in the cutting of the frond, in which it much resembles some of the forms of Trichomanes digitatum.—BAKER, in Hooker's Icones.

The United States National Herbarium contains a specimen collected by Cheeseman at Titirangi, near Auckland, likely to be a cotype, and at any rate authentic; also a sterile specimen from the Waitakerei ranges, without further data. The majority of the fronds are bifid or simple. If the segments are three or four, the central one is elongate. This would suggest a pinnatifid ancestry, but I still ascribe the species to *Microtrichomanes.*

A few fronds exceed 1 cm in length, but the majority are smaller, decurrent on the short stipe; segments rather more than 1 mm wide; teeth with a pluricellular base bearing a straight filament about four cells long; cell walls slightly thickened, pore-pitted, hyaline, straight; involucre acute at base and winged there, cleft scarcely to the wing, the valves broadly rounded, dark and firm, apparently entire. I have found but one sorus and have not ventured to dissect it.

Both Cheeseman and Holloway, Trans. N. Z. Inst. 54 (1923) 592, pl. 67, reduce this species to *H. Armstrongii,* on the ground that the dark margin, once supposed to distinguish the latter, is not a stable character. The testimony of local botanists, especially of one so particularly familiar with these plants as Doctor Holloway, is usually to be accepted; however, the few specimens I have seen seemed to differ in other respects as well as in the border. Whether they be one species or two, they are very reduced, and their affinity is thereby obscured. I list one under *Euhymenophyllum* and one under *Meringium,* noting in both cases that I suspect the plant of being *Microtrichomanes.*

New Zealand, endemic.

58. HYMENOPHYLLUM GRACILESCENS Domin.

Hymenophyllum gracilescens DOMIN in Bibl. Bot. 20 Heft 85 (1913) 23, *pl. 1, figs. 2–3.*

Gracile, rhizomate filiformi pertenui nudo repente sed nodoso, frondibus numerosis stipitatis; stipitibus filiformibus glabris exalatis fuscis circa 1½ cm longis; frondibus erectis oblongo-ellipticis circa 4–5 cm (raro usque plus 6 cm) longis et 2–2½ cm latis pinnatis; rhachi tenui glabra exalata i. e. tantum apice angustissime alata; pinnis laxis distantibus infimis 2-vel 3 furcatis brevioribus, mediis longissimis pinnati-furcatis lacinulis 3–5 instructis, superioribus bifurcatis, supremis simplicibus, segmentis, lacinulisque omnibus anguste linearibus vix 0.5 mm latis patentibus conspicue serrato-denticulatis, segmentis pluribus parte superiore ad venas angustissime alatas reductis et soros terminales gerentibus; indusio usque ad basin diviso, valvis laevibus circa 1¼ mm longis ovatis praecipue supra-denticulatis.

N. E.-Queensl.: Bellenden-Ker, zwischen 100–150 m (DOMIN XII. 1909).

Eine sehr charakteristische Art, schon habituell durch die lockeren, schmal-linealen, einfachen Blattsegmente sehr auffallend und von *H. tunbridgense* hinreichend verschieden.

Mr. C. T. White has lent me collections by *Watts* and by *Waller* supposed to represent this species, neither fitting the description perfectly. To the naked eye, the *Waller* collection, a single frond, is a perfect fit, except possibly as to the shape of the involucre, which is nearly round; but the marginal teeth are more attenuate, and the lip is broadly rounded, and entire or slightly denticulate, while Domin's figure shows it rather as pointed and sharply toothed. The laxness of the frond, the narrowness of the segments, and the long-stalked sori replacing plural segments, all distinguish it well from any other species. Whether or not it is a species distinct from *H. gracilescens*, differing most notably in the margin of the lip, may not well be decided from a single frond.

Endemic in Queensland.

59. HYMENOPHYLLUM TUNBRIDGENSE (L.) Smith. Plate 42.

Hymenophyllum tunbridgense (L.) SMITH, in Sowerby, Engl. Bot. (1794) pl. 162.

Trichomanes tunbridgense LINNÆUS, Sp. Pl. 2 (1753) 1098.

Hymenophyllum dregeanum PRESL, Hymen. (1843) 144.

Frondibus pinnatis; pinnis lobatis oblongis crenulatis.

Adianthum petraeum perpussilum anglicum, foliis bifidis trifidisque. *Raj. angl.* 3. p. 123. *Suppl.* 77.

Adianthum radicosum humisparsum s. Filicula pellucida nostras, coriandrifoliis mollicellis, globuliferum. Pluk. *alm.* 10. *t.* 3, *f.* 5. 6.

Darea tunbridgensis minor, *Pet. mus.* 761.

Muscus montanus italicus, adianti foliis. *Bocc. mus.* 2. p. 24. t. 2, f. 1. *Habitat in* Anglia, Italia.—LINNÆUS, loc. cit.

Rhizome and stipes finely filiform, glabrescent, stipes 1 to 3 cm long; fronds 2 to 5 cm long, ovate or narrower, tripinnatifid; rachis winged throughout; segments less than 1 mm wide, aculeate-serrate, with very few teeth except near the apices; cell walls thin, the internal ones obscurely pitted in British specimens; sori mostly on the very short lowest acropetal segments of the pinnæ, involucre cuneate and winged at the base, cleft to the wing, with broad valves, the lips regularly or irregularly sharply toothed, receptacle cylindric, included.

Scotland to Italy, the Azores and Madeira, the fronds larger and more lax in the warmer lands.

Hymenophyllum dregeanum of South Africa and Madagascar has still thinner walls, and the lips appear usually to be less, and less acutely, toothed—that is, obscurely toothed to crenate. A very lax form, given a varietal MS name by van den Bosch, has the lower part of the rachis terete. Taken with the geographic discontinuity, this sanctions the specific recognition of *H. dregeanum,* if one so please. However, I find some younger or better-preserved sori on Natal specimens with lips quite like those on topotypic *H. tunbridgense,* making it appear that, if they are held distinct, it must be chiefly on the basis of geographic distribution.

60. HYMENOPHYLLUM BARBATUM (van den Bosch) Baker. Plate 43.

Hymenophyllum barbatum (van den Bosch) BAKER, Syn. Fil. (1874) 68; NAKAI, Bot. Mag. Tokyo **40** (1926) 240.

Leptocionium barbatum VAN DEN BOSCH, Ned. Kruid. Arch **5**[3] (1863) 146.

Leptocionium flaccidum VAN DEN BOSCH, Ned. Kruid. Arch. **5**[3] (1863) 149.

Hymenophyllum flaccidum BAKER, Syn. Fil. (1868) 451, *non* van den Bosch (1859).

Hymenophyllum Khasianum BAKER, Syn. Fil. (1874) 464.

Hymenophyllum japonicum MIQUEL, Ann. Mus. Bot. Lugd.-Bat. **3** (1867) 183.

Hymenophyllum Henryi BAKER, Journ. of Bot. **27** (1889) 176.

Hymenophyllum oxyodon BAKER, Journ. of Bot. **28** (1890) 262.

Hymenophyllum fastigiosum CHRIST, Bull. Boiss. **7** (1899) 3.

Hymenophyllum omeiense CHRIST, Bull. Soc. Geog. Bot. **15** (1906) 101: cf. CHRISTENSEN, Acta Hort. Gothob. **1** (1924) 50, Cont. U. S. Nat. Herb. **26** (1931) 272.

Fronde ovata bipinnatifida, laciniis primariis patulis et divergentibus contiguis rhomboideo-ovatis (subcontiguis sinubus brevibus interstinctis 1–2 dichotomis simplicibusve, lacinulis latiusculis abbreviatis late undulatis,

margine minute et inaequaliter denticulato, apice rotundato truncato, rhachi flexuosis latissime alatis, venulis angulo patente earumque ramis 1–2 forcipatis simplicibusve angulo rotundato exeuntibus, cunctis nigrescentibus pilisque fuscis rectis rigidis opacis articulatis vestitis, cellulis teneris parum diaphanis mediocribus parvisque leviter elongato-hexaëdris acutangulis, parietibus rufescenti-hyalinis teneris subtilissime crenulatis, interaneis sive parietalibus, spatium amplum hyalinum relinquentibus, sive diffusis amorphis dilutis e rubro fuscidulis, soris in laciniis secundariis apicalibus parumper abbreviatis terminalibus immersis parvis ovatis, indusio fundo conico extus piloso late alato, ad medium fere usque bilabiato, labiis margine inaequaliter denticulato-serratis, stipite filiformi terete vel apice angustissime alato 1–2 cent. longo. Rhizoma setaceum horizontale ramosum intricatum glabrescens, frons 3–4½ cent. longa, 1½–2 lata membranaceae diaphana flaccidiuscula ex olivaceo rubro-fusca.

Hab. Ins. Tsou-Sima, WILFOOD [Wilford] (Hb. Hook.).

—VAN DEN BOSCH, op. cit. 146.

The reduction of *H. japonicum* was made by Nakai, by comparison of the types in the Herbarium Lugduno-Batavum, and I verify it by the same test. The reduction of *H. Henryi* and *H. omeiense* is by Christensen, is verified as to the former, and is accepted as to the latter. Christensen (op. cit. 272) has also observed that *H. khasianum* "very likely represents a larger tropical form" of *H. barbatum;* the frond length given by van den Bosch is 3 to 4.5 cm for the latter, 4 to 4.5 cm for the former. The smaller specimens commoner in herbaria as *H. barbatum* should have been called *H. japonicum* by those who maintained that species.

Rhizome filiform, hairy but glabrescent, black or dark, intricate and, with the fronds, mat-forming; stipe wiry, dark, glabrescent, 1 to 4 cm long, usually much shorter than the frond; frond 2 to 8 cm long, ovate to round and to broadly lanceolate, bi- or tripinnatifid, base usually broad and apex rounded, rachis with a wing decurrent onto the stipe, usually plane but sometimes wavy or even crisped, axes hairy at first, finally sparsely so or naked; pinnæ crowded, imbricate, or subremote; veins forking at a wide angle and therefore zigzag, very prominent, brown to black; segments commonly 1 mm wide, sometimes wider, separated by rounded sinuses, usually so shallowly that the axis of the pinnæ (and pinnules) are more broadly laminate than the rachis and segments (as in *H. exsertum*), margin variously denticulate or serrulate; walls varying from irregularly slightly thickened and wavy or crenulate (in Japan) to much thickened and coarsely pitted, with the disappearance of waviness (in warm lands); sori usually not abundant, and axial or subterminal, rarely abundant and then usually crowded near

the apex, involucre cleft to the base, back naked (or with a few hairs), lips dentate with attenuate teeth, receptacle included.

I have in hand the types or specimens of the type collections of *H. barbatum, H. khasianum* (*L. flaccidum*), *H. japonicum, H. Henryi,* and *H. oxyodon,* and therefore reduce them with adequate knowledge of what they are, whether or not the reductions are accepted.

As originally described, *L. flaccidum* was best distinguished by peculiar form of sorus, only one being seen; beyond this, its rachis had a wavy wing and the veins forked at an acute angle. I find none of these criteria either constant or peculiar.

Hymenophyllum japonicum is a small form, with veins said to branch at an acute angle. The size—1 inch or less long—is commoner in herbaria than the typical one of *H. barbatum,* but there is no line between them, in Japan, or Yunnan whence we have most specimens, nor probably anywhere else. As to the angle of branching, Plate 43, fig. 1, represents a frond of the type; the branches seem to me to stand at a rather wide angle. The most distinct form is that aptly named *H. oxyodon,* with widely divergent attenuate teeth, described from Tonkin, said also to be glabrous; "glabrescent" would be correct—the type collection is not quite hairless. I reduce it because it ranges at least to Kiangsi, *Steward 4673,* overlapping and intergrading with more typical plants all the way, and because in Tonkin too more typical forms occur.

Besides these salient teeth, there are two other peculiarities more or less peculiar to the southern and western part of the range of the species: Thickness of walls, and waviness or crispiness of wings and segments. Within the species, no line can be drawn between one type of wall and another, and a considerable part of the variation within the species as here construed is often present on different parts of a single frond. It is true, though, that, from southern China, south and west, the walls are more thickened, and therewith less wavy or crenulate than in Japan.

As to planeness of frond, it is not always plane in Japan, and sometimes is plane in Yunnan and Tonkin. However, real crispiness is commoner and more extreme in the south and west. The most crisped specimen I include here is an unnumbered collection by G. Mann, from the Jainta Hills, altitude 3,500 feet, April, 1889, distributed as *H. Neesii.* Several collections from Tonkin are somewhat crisped, making me suspect that *H. Poilanei* is only an extreme case.

Hymenophyllum fastigiosum is represented in U. S. Nat. Herb. by *Hancock 206*, from the type locality, with Christensen's identification, "t. sp. orig. Henry 11859;" also, by *Pételot 4065*, from Chapa, Tonkin, probably identified by Christensen. Neither is really naked or very nearly so. The walls are exactly those of *H. barbatum* of the same region—the old ones much but irregularly thickened and pitted, those of younger parts of the same frond less thickened, with more evident wavings. The sole difference from *H. barbatum* is in size, and this difference, as to specimens seen, is inconsiderable, a maximum frond length of 9 cm, as against 8 cm in a specimen from Japan.

Specimens: JAPAN, *Wilford 846* (type), *Keiske* (type of *H. japonicum*), *Buerger, Textor, Watanabe, Coville, Holbrook, Sakurai, Tanaka 123, Faurie 4637, 5259.* FORMOSA, without data. KOREA, *Taquet 3636.* CHINA, *Henry 5457* (type coll. of *H. Henryi*), *Ching 2127, 8611, Steward 4673, Wilson 24, Matthew 12, Chung 3583, Merrill 10188, 10980, Hancock 139, 206, Rock 7186a.* INDIA, *Hooker and Thomson* (type fragment of *L. flaccidum*, and another sheet), *G. Mann.* TONKIN, *Balansa 1905* (type coll. of *H. oxyodon*), *Pételot 577, 3333, 3340, 3342, 3601, 3602, 4355.* BURMA, *Rock 7442, 7445a.*

The affinities of this species seem to me literally to be tangled. It is *Hymenophyllum* in the strictest sense; that is, not too remotely related to *H. tunbridgense.* We have long been used to regarding the species with entire margin and those with toothed margin as forming two distinct series, and confining ourselves strictly to its own series in discussing the affinities of any species. Contrary to this practice, I suspect that *H. Reinwardtii* is related rather to species with entire margin; but it is not a typically serrate species. I have the belief, rather than the suspicion, that *H. barbatum* also has relatives with entire margin. The limited resemblance of *"H. japonicum"* and *H. Wrightii* is perhaps the consequence of common environment, but I believe that there is some measure of genetic affinity to *H. exsertum*, much closer than the remote ancestral connection of the entire and the toothed groups as a whole.

60a. HYMENOPHYLLUM POILANEI Tardieu and Christensen.

Hymenophyllum Poilanei TARDIEU and CHRISTENSEN, Bull. du Muséum 6 (1934) 289.

Leptocionium parvum, L. acanthoidi v. d. B. (Hym. Jav. pl. 32) divisione crispataque fronde valde simile, sed minori et rachi pilosa, indusiis dorso non vel inconspicue spinuliferis diversum. Fronde deltoideo-ovata, stipite nigro, exaltato, 1–2 cm. longo: lamina 1–4 cm. longa, 0.5–2 cm.

lata, bi-tripinnatifida undulato-crispata, lobis ultimis spinescenti-dentatis, rachi crispato-alata, subtus pilis ferrugineis sparse onusta. Soris medium divisis margine exteriore lato profunde dentatis, dorso non vel inconspicue spinuliferis.

Annam: Massif du Hon Ba, août 1919, Vincens, sans n°.- Nhatrang, 1.600 m., mai 1922, Poilane, n° 3,478 (pp.) et 3.704 (type in Herb. Mus. Paris).

Se rapproche de l'*H. Khasianum* Bak. par sa forme, sa texture, la présence des nombreux poils ferrugineux sur le rachis, et ses segments spinuleux. En diffère par sa plus petite taille, son rachis a aile tres ondulée, ses segments extrêmement crispés, ses sores localisés à la partie supérieure. Il diffère des espèces malaises crispées, *H. Neesi*, *H. aculeatum*, par son rachis poilu.—TARDIEU AND CHRISTENSEN, loc. cit.

I have not seen a specimen. I have identified other Tonkin specimens with more or less crisped wing and segments as *A. barbatum*, and suspect that I would do the same with this. It is noted that Christ described his *H. fastigiosum* (which I regard as merely a large *H. barbatum*) as either plane or crisped.

61. HYMENOPHYLLUM SIMONSIANUM Hooker. Plate 44.

Hymenophyllum simonsianum HOOKER, 2d Cent. (1860) pl. 13; HAYATA, Ic. Formos. 5 (1915) 258, *fig. 92.*

Didymoglossum simonsianum VAN DEN BOSCH, Ned. Kruid. Arch. 5^3 (1863) 145.

Caudice filiformi gracili longe repente, frondibus solitariis distantibus oblongo-lanceolatis membranaceis laxis fuscis bipinnatifidis in stipitem brevem gracilem basi attenuatis apice obtusis, lobis primariis semiuncialibus oblique cuneatis sub lente argute serratis margine inferiore truncatis integris superiore cum apice lobato-pinnatifidis, lobulis paucis (3–5) obtusissimis, involucris in lobis terminalibus frondis ovalibus subobovatisque exsertis profunde bivalvibus, valvis convexis subspinuloso-serratis, venis apice clavatis, soris inclusis receptaculum tegentibus.

Hab. Khasya Hills, Eastern Bengal, *Simons.*

This does not appear to be anywhere described, though it must be confessed, that in so extensive a natural genus, it is very difficult, and in a few words, to define the character of any particular kind. Accurate figures are most to be depended upon.—HOOKER, loc. cit.

Van den Bosch's only published comment is "Species pulcherrima et distinctissima." His unpublished notes place the plant more correctly, as *Leptocionium,* and contain an expression I find nowhere else in his manuscripts, "parietibus . . . aegre distinguendis."

Stipe 2 to 4 cm long, wiry, dark; frond 4 to 7 cm long, about 2 cm wide (the notes of van den Bosch, probably based on study of the type, say stipe 3 to 6 cm, frond 8 to 11 cm by 1.5 to 2 cm wide), rachis winged throughout, it and the veins hairy at first but glabrescent; pinnæ few, short, broad, the lower with 2 to 4

segments 3 to 5 mm long, 3 mm wide, rounded, with comparatively small and rather fragile teeth; walls in all specimens at first very thin and in part permanently so, straight as a whole but finely wavy in detail, presently most irregularly thickened, not quite perpendicular to the surface and therefore obscured by the dense, closely applied cell contents and usually appearing as an irregular chain of clear spots or irregularly placed short streaks; sori terminal on segments 1 to 1.5 mm wide, winged at base only, involucre 2 mm wide and long, cleft nearly to the base, lips rounded, sharply dentate, receptacle cylindrical, included.

Described from Khasia. All Indian specimens seen are from Sikkim or near it: *Hooker* in Gray Herb., *Henderson* in U. S. Nat. Herb., and collector not stated in Gray Herb. and Herb. Lugd.-Bat. from Darjeeling, Kew dist. *128*. Formosa, Arisan, *Faurie 624*, *Hayata*.

Related to *H. barbatum*, but a thoroughly distinct species. There is a suggestion of *H. edentulum* in the structure of the walls.

62. HYMENOPHYLLUM REVOLUTUM Colenso.

Hymenophyllum revolutum COLENSO, Tasm. Journ. 2 (1844) 186.
Hymenophyllum zeelandicum VAN DEN BOSCH, Ned. Kruid. Arch. 5^3 (1863) 175.
Hymenophyllum pusillum COLENSO, Trans. New Zealand Inst. 12 (1880) 365.
? *Hymenophyllum pygmaeum* COLENSO, Trans. New Zealand Inst. 13 (1881) 376.
Hymenophyllum tunbridgense C. Chr. *part.*, Cheeseman, HOLLOWAY, Trans. N. Z. Inst. 54 (1923) 592, *pl. 68*, *vix* Smith.

Plant, small, climbing, few fronded, sub-erect and spreading, glabrous, epiphytical. *Frond,* ovate or oblong-lanceolate, obtuse, pinnate-pinnatifid or sub-bipinnate, 2–5 inches; dusky green. Pinnules; somewhat trapeziofalcate, petiolate, alternate, distant, pinnatifid, 3–12 lobed: *Lobes* linear-oblong, truncate, deeply serrate or sublaciniate; serratures acute and somewhat hooked; mostly four laciniations at apex, decurrent, revolute; lowermost wedge-shaped and deeply bifid. *Involucre,* obovate or sub-rotund, inflated, laciniated, supraaxillary, solitary, pedicelled; pedicel, margined: *Valves,* large, open: *Receptacle,* exserted. *Rachis,* flexuose, margined towards apex; margin, serrate; serratures, distant. *Stipe,* filiform, cylindrical, brittle, finely striated, tortuous, 1–1½ inches long. *Caudex,* creeping.

Hab. On sides of prostrate and reclining trees, shores of Waikare Lake; December, 1841.

Obs. A species possessing very close affinity with *H. Tunbridgense, Sm.*—COLENSO, Tasm, Journ. 2: 186.

All of the "species" treated here have been reduced to *H. tunbridgense* (or *H. peltatum,* in error), which I do not find

present from New Zealand. For one thing, all New Zealand specimens have the rachis largely wingless.

Specimens in hand are *Hooker, Brackenridge* (type collection of *H. zeelandicum*), *Kirk 227, 565, 570, Cheeseman, Ranft 7, Holloway, Setchell.*

None of these has a frond 5 inches long, the range being from 8 cm, exclusive of stipe, down to less than 2 cm (fertile). The receptacle is somewhat extruded, or equals the valves, or is shorter; I am quite sure that in this case the difference is not diagnostic. In poorly fruiting material the sori are axillary, as in *H. tunbridgense,* but on contracted segments. In fuller fructification the sori tend to become terminal.

This is as I see it. But I know well that the man in the field can know his plants better than the man in the herbarium, and on that ground would mistrust my judgment in reducing Colenso's three species to two or one, except that the reduction is accepted by Holloway. However, dwarfs in general are derived from plants of more usual size. The two being surely nearly related, *H. pusillum* would probably be derived from *H. revolutum,* and could hardly become specifically fixed in the actual presence of the ancestral form; and they have the same type locality—Lake Waikare. If they are distinct, the name of the smaller form is *H. zeelandicum.*

I have no specimen fitting the description of *H. pygmaeum,* which is very like that of *H. minimum.* Colenso, however, was very positive that they are distinct and not nearly related.

Qualifying the statement that I do not recognize *H. tunbridgense* in New Zealand, a specimen collected by *Setchell* near Wairakei May 9, 1904, and determined by Cheeseman as *H. multifidum,* should be noted. The fertile fronds are 1.5 to 2.5 cm long, bipinnatifid. The rachis, carefully examined, is marginate to the base, which would make it *H. tunbridgense.* The wing is so inconspicuous that, in New Zealand, I prefer to call it *H. revolutum.* Larger fronds in the same collection (4 to 5 cm long) are dwarfed *H. multifidum,* with entire lips and toothed wing. Cheeseman's identification may be correct as to the whole collection. The disappearance of teeth on the obsolescent wing of extreme dwarfs might be expected. But I have seen no other *H. multifidum* with regularly dentate lips or with segments as broad as those of these dwarfs.

63. HYMENOPHYLLUM CUPRESSIFORME La Billardière.

Hymenophyllum cupressiforme La Billardière, Nov. Holl. Pl. Sp. 2 (1806) 102, *pl. 250, fig. 2;* Willdenow, Sp. Pl. 5 (1810) 522.

Hymenophyllum frondibus pinnatis, oblongis; soris supraaxillaribus, solitariis; indusiis ut pinnae subbipinnatifidae serratis.

Filix palmaris, surculo repente, ferrugineo-tomentoso ut radiculae aut nudo. Frons pinnata, oblonga, subfusca, pinnis alternis, patentibus, pinnatifiidis, serratis, unguicularibus, laciniis oblongis, simplicibus aut bipartitis; stipite brevi, filiformi. Sori oblongi, supraaxillares, solitarii; columnula frugifera subclavata, inclusa; indusiis obovatis, bivalvibus, serratis. Alias ut in specie praecedenti.

Habitat in capite Van-Diemen.—La Billardière, loc. cit.

Of this I have no authentic specimen. It is represented by *Herb. Lugd.-Bat. 908, 282–744,* by a specimen from Kew without a complete sorus. *U. S. Nat. Herb. 825785,* from Blue Mountains, Australia, without further data, seems to be the same; the lips of its involucre are toothed at the apex. Neither of these has a winged rachis, except near the apex, while Willdenow says "rachi alata subserrata." Both authors agree that the lips are toothed, but La Billardière's figure, with teeth on the sides of the valves, is hardly credible.

It may be that, as Cheeseman has stated, this is the species just described as *H. revolutum;* in which case the latter, of course, becomes a synonym.

64. HYMENOPHYLLUM PUMILUM C. Moore. Plate 45, figs. 1 to 3.

Hymenophyllum pumilum C. Moore, in Baker, Syn. Fil. (1874) 464.
Hymenophyllum Moorei Baker, Syn. Fil. (1874) 464.

H. pumilum, C. Moore; *rhizome* capillary, wide-creeping; *st.* filiform, ¼–½ in.; *fr.* ½–¾ in. l., roundish in upper, cuneate in lower half, flabellato-bipinnatifid; *divisions* ligulate, close, 1-veined, ½ lin. br., obscurely denticulate, upper simple, lower deeply forked or trifid; *surfaces* naked; *sori* one to a frond, terminal; *inv.* deeply cleft with ovate entire lips.

Hab. Mount Tomah, New South Wales, *C. Moore.*—Syn. Fil. loc. cit.

The United States National Herbarium contains a specimen, from the National Herbarium, Victoria, Melbourne, collected by Moore on Lord Howe Island in 1872—that is, prior to publication, labeled "Hymenophyllum pumilum C. Moore." The locality is the more likely to be correct, because there is another collection by Watts in 1911, from Mount Gower, Lord Howe Island. Domin cites also Mill Creek, in New South Wales.

Fronds 2 to 3 cm long, the more ample ones with a terete rachis above the usually single free lowest pinnæ; pinnæ, the lowest

with three or four segments, the intermediate forked, the higher ones simple, 1.5 to 2 mm wide, apex abrupt but mostly not retuse, teeth few, each consisting of a row of about three cells on a broader base; internal walls slightly, somewhat irregularly thickened; sorus on a short, very narrow apical segment far exceeded by sterile segments; involucre 2 to 3 mm wide, divided down to a broadly obconic base, the lips fimbriate; receptacle slender, half as long as the involucre.

The publication of *H. Moorei* follows immediately that of *H. pumilum* and the sole difference is that the latter is said to have entire lips. Our specimens, labeled *H. pumilum*, is certainly *H. Moorei*. There may have been an error in labeling, but I think it more likely that Baker was in error as to the lips.

65. HYMENOPHYLLUM PUMILIO Rosenstock. Plate 45, figs. 4 and 5.

Hymenophyllum pumilio ROSENSTOCK, in Fedde's Repert. 9 (1910) 72.

Leptocionium; rhizomate repente, filiformi, ramoso, caespitoso, frondiculos 0,5–1.5 cm remotos emittente; stipitibus filiformibus, teretibus, 3–6 mm longis; laminis ovatis, usque ad 5 mm longis, 2–4 mm latis, olivaceis vel olivaceo-fuscis, glaberrimis, pinnatis; pinnis 1–3 utrinque, maximis ad 2 mm fere longis, vix 1 mm latis, alternis, remotiusculis, sessilibus, superioribus breviter decurrentibus, basalibus liberis, omnibus simplicibus, lineari-oblongis, margine dentibus remotis, elongatis instructis, uninerviis; soris apicalibus, magnis, basi altera anguste alatis; indusiis cuneato-oblongis, ad ⅓ fere bilobis, lobis semicircularibus, antice manifeste denticulatis, receptaculo breviter exserto.

Nova Caledonia: In monte Tao, ad arborum truncos; 1910, l. *Franc no. 1433.*

Diese rasenartig wachsende Zwergform kommt an Gestalt und Grösse dem *Hymenophyllum minimum* Rich. am nächsten, das sich jedoch durch zahlreichere und dichter stehende, stets imbrikate Fiedern, durchweg geflügelte Rhachis, sowie durch dornige Bewehrung der Indusiumklappen von ihr unterscheidet.

Cotypes are in the U. S. Nat. Herb. and the Herb. Univ. Calif. (as *Fil. novocaled. exsicc. 172*). They are as described. Only exceptionally large fronds, with three pairs of pinnæ, have any wingless rachis. The pinnæ are strikingly abrupt at the apex. The cell walls are somewhat thickened at the corners, otherwise uniformly rather thin. Many fertile fronds have a single pair of sterile pinnæ. The involucre is 1 mm wide and slightly longer, but looks huge, compared with the frond. The sides of the tube are straight, and wingless except at the very bottom. The lips are short, very broadly rounded, and beautifully toothed.

The differences from *H. minimum* are not as great as Rosenstock supposed. If the Steward Island material, *Kirk 574*, cor-

rectly represents that species, its pinnæ may be no more numerous nor more imbricate than those of *H. pumilio;* and, as already noted, most fronds of our cotypes of *H. pumilio* have no terete rachis. The one conspicuous and apparently constant distinction is that the involucres of *H. minimum* are armed on the back.

Known by the type collection only.

66. **HYMENOPHYLLUM LEVINGII C. B. Clarke.**

Hymenophyllum Levingii C. B. CLARKE, Trans. Linn. Soc. Bot. 1 (1880) 439, *t. 49, fig. 3.*

Frond small, narrowly oblong, not crisped, pinnatifid to the winged rhachis; primary segments 1–4-lobate; ultimate segments oblong, remotely serrate, their midrib with many hairs and lanceolar scales of the same texture as the frond. (Pl. XLIX. fig. 3.)

Sikkim; Yoksun and Neebay, alt. 7000 feet, *C. B. Clarke.*

Very delicate in texture. Stipe 1 in., with moniliform hairs. Frond 1–2 in. long, more or less covered with moniliform hairs. The lanceolar scales on the midrib beneath are attached by their whole base; they are sometimes rare, sometimes very numerous, so as to form a thick coat beneath the frond. Involucres usually 1–2 at the end of the segment, small, glabrous, subquadrate, valves separating nearly to the base, entire or slightly toothed at the apex; capsules of Hymenophyllum 2–4 to each involucre, carpophore included.—This is not much like any other species of the genus.

Anything like "lanceolar scales of the same texture as the frond" is otherwise unknown in the family, unless it be the laminar outgrowths of *Amphipterum,* and the broken-up wings of *Ptychophyllum, Buesia,* and *Myriodon.* I have seen no specimen of this species. Perhaps it should be regarded as constituting a monotypic subgenus.

7. Subgenus MECODIUM (Presl)

Mecodium PRESL, Epim. (1852 ?) 258.
Diploophyllum VAN DEN BOSCH, Erste Bijdrage (1861) 322.
Euhymenophyllum of many authors.

Fronds pinnately compound or decompound, margins entire and hairless; cell walls typically uniformly thin; indusium cleft to the base, or, if partly immersed, down to the lamina of the frond, receptacle included.

Neither *Mecodium* nor *Diploophyllum* was well published. The former has hardly the pretense of a description, but is authenticated by the citation of a species, *M. sanguinolentum;* the latter is adequately characterized, but no binomial was formed. *Diploophyllum* would be a most inappropriate name for the large group here presented.

I include in *Mecodium* several small aberrant groups and species, with hairy leaves, with toothed margin, and even with laminæ two or more cells thick. In no case have I any doubt that this is their real affinity; and in every case the generic separation of these aberrant plants would result in new difficulties of definition more serious than those it would cure.

I have no other name than teeth for the marginal irregularities of *H. Reinwardtii* and *H. samoense,* but they are not homologous with the teeth of *Meringium,* and do not indicate any affinity to that group.

I cannot recognize the species with lamina more than one cell thick as constituting a subgenus or genus, because they seem each to have its own distinctive affinities to species of ordinary texture. If there had to be a genus *Diploophyllum,* it would probably best have two dissimilar species.

Mecodium is pantropic, and has about fifty Old World species, when *H. polyanthos* is most broadly construed.

Key to the species of the subgenus Mecodium.

Lamina uniformly one cell thick.
  Margin entire.
    Fronds glabrous.
      Receptacle filiform to clavate.
        Involucre not subtended by conspicuous branches of costa.
          Rachis winged throughout.
            Wing of axes plane or at most undulate.
              Fronds commonly 5 to 15 cm long.
                Fronds odorless.
                  Lips entire or crenate. (Cosmopolitan.) .... 67. *H. polyanthos.*
                  Lips sharp-toothed. (Malaya.) 75. *H. productum.*
                Fronds scented. (New Zealand.) 74. *H. sanguinolentum.*
              Fronds larger.
                Frond linear. (New Guinea.) 69. *H. ooides.*
                Frond broader.
                  Rhizome over 1 mm thick. (New Zealand.) .... 109. *H. pulcherrimum.*
                  Rhizome very slender.
                    Distal segments elongate. (Hawaii.) .... 70. *H. recurvum.*
                    Distal segments not elongated. (Africa.) .... 68. *H. Kuhnii.*
              Fronds smaller.
                Involucre roundish.
                  Lips crenate or lobed. (Philippines.) 71. *H. angulosum.*

Lips entire.
Sori crowded at apex. (Philippines.) ..72. *H. paniculiflorum.*
Sori few or scattered.
Walls uniformly thin. (Japan, etc.)
106. *H. Wrightii.*
Marginal walls toothed. (Luzon.)
73. *H. nitiduloides.*
Involucre ovate, acute. (New Caledonia.) .... 86. *H. LeRatii.*
Wing crisped.
Lips entire. (China.) ...... 83. *H. corrugatum.*
Lips lobed or sublacerate.
Receptacle linear. (Malaya, etc.)
80. *H. javanicum.*
Receptacle columnar. (Japan.)
82. *H. riu-kiuense.*
Lips fimbriate. (Philippines.)
81. *H. fimbriatum.*
Rachis terete in lower part.
Fronds odorless.
Pinnæ pinnately divided.
Frond 20 cm long. (Malaya, etc.)
79. *H. emarginatum.*
Frond under 10 cm long. (Philippines.)
71. *H. angulosum.*
Pinnæ rather flabellately divided.
Naked or slightly hairy. (Australia, etc.) .... 84. *H. flabellatum.*
Bearing very long hairs. (New Zealand.) .... 85. *H. rufescens.*
Fronds odorous .... 74. *H. sanguinolentum.*
Involucre subtended by branches of costa; small ferns.
Fronds not deltoid.
Fronds tripinnatifid.
Fronds 4 to 6 cm wide. (Rarotonga.)
88. *H. involucratum.*
Fronds under 2 cm wide. (Madagascar.)
94. *H. veronicoides.*
Fronds simple to pinnatifid.
Internal walls thick. (New Zealand.)
91. *H. montanum.*
Internal walls thin.
Frond normally over 6 cm long. (Australia, etc.) .... 87. *H. rarum.*
Frond normally under 4 cm long.
Pinnæ flat.
Fronds round-elliptic. (Queensland.) .... 89. *H. Walleri.*
Fronds narrower or deltoid. (South Africa.)
93. *H. fumarioides.*

Lower side of pinnæ rolled upward. (New Caledonia.) 90. *H. mnioides.*

Fronds deltoid.

Walls thickened and pitted. (Tasmania.) 92. *H. intricatum.*

Walls thin. (Madagascar.) .... 95. *H. Humbertii.*

Receptacle capitate.

Wing and lamina flat.

Fronds large, over 10 cm long.

Rhizome slender.

Fronds in general ovate.

Head of receptacle globose. (Malaya; Polynesia.) .... 96. *H. imbricatum.*

Head of receptacle dilated.

Involucre crenate. (Malaya to India.) .... 101. *H. badium.*

Involucre entire. (Malaya.) 98. *H. Junghuhnii.*

Fronds narrowly lanceolate. (Java to Papua.) .... 99. *H. longifolium.*

Rhizome over 1 mm thick. (New Zealand.) 109. *H. pulcherrimum.*

Fronds smaller (under 10 cm).

Receptacle dilated. (Java.) .... 100. *H. salakense.*

Receptacle not dilated. (Java, etc.) 97. *H. Treubii.*

Wing more or less crisped.

Walls thin, not pitted.

Fronds over 15 cm long.

Segments as wide as wing. (India, Malaya.) 101. *H. badium.*

Segments narrower than wing. (New Zealand.) .... 108. *H. flexuosum.*

Fronds under 15 cm long.

Sori central on frond. (Japan.) 104. *H. flexile.*

Sori more distal. (India to Philippines.) 102. *H. crispatum.*

Walls thick and pitted.

Fronds thin. (Formosa.) 103. *H. crispato-alatum.*

Fronds coriaceous. (Papua.) .... 105. *H. opacum.*

Axes persistently hairy.

Fronds odorless.

Sori distal. (Japan, China.) .... 106. *H. Wrightii.*

Sori axillary. (India.) .... 107. *H. exsertum.*

Fronds odorous. (New Zealand.) .... 110. *H. villosum.*

Margin irregularly, bluntly toothed.

Wing slightly crisped. (Samoa; Queensland.) .... 78. *H. samoense.*

Wing moderately crisped. (Malaya.) .... 76. *H. Reinwardtii.*

Wing exceedingly crisped. (Philippines.) .... 77. *H. thuidium.*

Lamina partly or wholly two cells thick.
  Rachis winged throughout. (Tasmania, etc.) .... 111. *H. australe.*
  Rachis terete below. (New Zealand.) .... 112. *H. demissum.*
Lamina three cells thick throughout.
  Hairs on stipe coarse and long. (New Zealand.) .... 114. *H. scabrum.*
  Hairs ordinary. (New Zealand.) .... 113. *H. dilatatum.*

67. **HYMENOPHYLLUM POLYANTHOS** Swartz. Plates 46 and 47.

Hymenophyllum polyanthos SWARTZ, Schrad. Journ. 1800[2] (1801) 102 (not seen); Synopsis (1806) 149.

Trichomanes polyanthos SWARTZ, Prod. Fl. Ind. Occ. (1788) 137.

? *Trichomanes inaequale* POIRET, in Lam. Enc. 8 (1808) 74.

Hymenophyllum inaequale DESVAUX, Prod. (1827) 335.

Hymenophyllum gracile BORY, in Willd., Sp. Pl. 5 (1810) 527; HOOKER and GREVILLE, Ic. Fl. *pl. 198.*

Sphaerocionium gracile PRESL, Hymen. 127.

Hymenophyllum emarginatum NEES and BLUME, (spec. *908, 281–725 Herb. Lugd.-Bat.*) et al., *non* Swartz.

Hymenophyllum pectinatum NEES and BLUME, Nova. Acta 11 (1823) 124, *pl. 12, fig. 5, non* Cav.

Hymenophyllum tenellum DON, Prod. Fl. Nepal. (1825) 12.

Hymenophyllum blumeanum SPR., Syst. Veg. 4 (1827) 131; VAN DEN BOSCH, Hymen. Javan. 46, *pl. 36.*

Meringium (?) *blumeanum* PRESL, Hymen. 116.

Hymenophyllum integrum VAN DEN BOSCH, Pl. Jungh. (1856) 563, Hymen. Javan. 49, *pl. 38.*

Hymenophyllum pycnocarpum VAN DEN BOSCH, Pl. Jungh. (1856) 564, Hymen. Javan. 48, *pl. 37.*

Hymenophyllum acrosorum VAN DEN BOSCH, Pl. Jungh. (1856) 564.

Hymenophyllum microsorum VAN DEN BOSCH, Ned. Kruid. Arch. 5^3 (1863) 155.

Hymenophyllum himalaianum VAN DEN BOSCH, Ned. Kruid. Arch. 5^3 (1863) 156.

Hymenophyllum osmundoides VAN DEN BOSCH, Ned. Kruid. Arch. 5^3 (1863) 164.

Hymenophyllum sphaerocarpum VAN DEN BOSCH, Ned. Kruid. Arch. 5^3 (1863) 167.

Trichomanes microchilum BAKER, Trans. Linn. Soc. Bot. II 4 (1894) 250.

Hymenophyllum microchilum CHRISTENSEN, Mitt. Inst. Bot. Hamburg. 7 (1928) 7; Gardens' Bull. 7 (1934) 212.

Hymenophyllum subdemissum CHRIST, Bull. Boiss. 6 (1898) 140.

Hymenophyllum fujisanense NAKAI, Bot. Mag. Tokyo 40 (1926) 249.

Hymenophyllum constrictum HAYATA, Ic. Pl. Formos. 4 (1914) 140, *fig. 80, non* Christ.

Hymenophyllum parallelocarpum HAYATA, Ic. Pl. Formos. 4 (1914) 141, *fig. 82.*

Hymenophyllum punctisorum ROSENSTOCK, Hedwigia 56 (1915) 333.

Hymenophyllum pantotactum v. A. VAN ROSENBURGH, Bull. Jard. Bot. Buitenzorg No. 7 (1912) 20.

Hymenophyllum gracilius COPELAND, Bishop Mus. Bull. 93 (1932) 7, *pl. 3.*

Hymenophyllum epiphyticum J. W. MOORE, Bishop Mus. Bull. 102 (1933) 5.

Frond. tripinnatis deltoideis, rachide stipiteque marginatis, pinnis decurrentibus, pinnulis linearibus obtusis integris. Flor. Ind. occ. p. 1757. Hedw. fil. ic. Jamaica.—SWARTZ, Synopsis 149.

The usually accepted name of this as a species of the Malay region has been *H. blumeanum.* This is so well established in literature that I quote its publication and Blume's amplification.

H. fronde lineari pinnatifida, laciniis obtusis sub-pinnatifidis. *Java.* (H. pectinatum Nees.)—SPRENGEL, loc. cit.

H. fronde lanceolata pinnatifida aut bipinnatifida fusca glabra, pinnis alternis approximatis cuneato-oblongis pinnatifidis, laciniis linearibus subbifidis obtusis parum retusis, involucri valvis subrhombeo-ovatis obtusis, stipite tereti. Spr. Syst. veg. 4. p. 131.4. *Hymenophyllum pectinatum* Nees et Bl. in Act. Nat. Cur. 11 t. 12. f. 5.

Obs. Ab *Hymenophyllum sanguinolento,* Sw., cui proximum, differt fronde angustiore et laciniis seu pinnulis secundariis haud palmato-pinnatifidis.

Crescit in Javae arboribus locis montanis.—BLUME, Enum. 220.

A plant is described here, first as linear, then as lanceolate. It is brownish green, bi- or tripinnate, with narrowly winged rachis; segments narrow, perfectly entire; involucre ovate to broadly ovate. Amplifying the description, the pinnules, at least the basal, tend to be flabellately divided; the segments are short; the internal cell walls are uniformly thin, the marginal ones irregularly thickened or toothed on the inside; and the base of the involucre is broadly winged (that is, sunk in the apex of the segment), cleft down to the wings, the lips broadly rounded or somewhat narrowed towards the rounded tip; receptacle slender, included, with inconspicuous sporangiophores. It ranges from Java to India and New Guinea. It is easily distinguished from typical *H. polyanthos* by the slender fronds, winged base of involucre, and marginal walls.

And yet, I cannot in practice distinguish them, because—

1. The frond form of *H. blumeanum* is not characteristic at all; in more typical (in the sense of the plant, not of nomenclature) development, this plant is in Java narrowly ovate or ovate.

2. The winged base of the involucre is very inconstant; in the type locality (and most other places), the wing may be nar-

row and very short, so that the involucre is cleft almost to the base, and the fertile segment may be narrowed, as in typical *H. polyanthos.*

3. The marginal wall, if constant in Java, is not so in several other parts of the range, where I have found it uniformly thin, and irregularly thickened, on the same fronds.

4. At least along the northern part of its range—India, China, Formosa, and Japan—it blends with typical *H. polyanthos.*

5. *Hymenophyllum polyanthos* in America, as generally construed, exhibits at least an equally wide range of variation—even more synonyms are cited there.

At this point I quote Hooker, Sp. Fil. 1: 107: "The extreme states of this species are indeed easily recognized and easily described; but there are various intermediate grades that baffle all attempts to discriminate them specifically." Christensen also, Med. Goteborgs Bot. Trädgard 1 (1924) 50: "It is difficult to see how *H. blumeanum* can be distinguished from the genuine *H. polyanthos* Sw. from tropical America." Also Rosenstock, on his label of *Mousset Kz,* "(polyanthos Sw.) Blumeanum Spr."

As to the synonyms of *H. blumeanum:*

Hymenophyllum acrosorum was intended to distinguish the form with broader fronds, which I regard as the more typical development; its author almost immediately recognized the identity of the two forms—Hymen. Javan. 47–48.

Hymenophyllum pycnocarpum was described from two specimens from the same locality as *H. blumeanum,* distinguished by somewhat broader frond, less winged base of involucre, and more pointed lips. *Hymenophyllum integrum,* described from one specimen, had a broader, more rounded involucre than *H. pycnocarpum.* With van den Bosch's and abundant other material in hand, I agree with the Buitenzorg pteridologists, Raciborski (who does not mention them), and van Alderwerelt, Malayan Ferns 71, that neither of these is even varietally distinct.

Most botanists since van den Bosch have not recognized *Hymenophyllum himalaianum, H. osmundoides,* and *H. sphaerocarpum* as distinct from *H. polyanthos,* respectively *H. blumeanum.* They are represented in their author's herbarium, in the Herbarium Lugduno-Batavum, by fragments too small and imperfect, by themselves, to permit reappraisal; *H. himalaianum,* described as a very small fern, with flexuous stipe, undulate segments sometimes strongly dilated at the apex, thick walls, and rather large involucres, and compared only with *H. paniculiflorum,* would seem reasonably distinct—by description. I believe that

it is represented by a *Hooker and Thomson* specimen from Khasia (the type source should be Nepal) in the Gray Herbarium; and by a collection by *Strachey and Winterbottom,* cited also by van den Bosch. Like these are a collection by Mann from Assam, and *Kerr 6083* from Siam. To me, they are all dwarfed *H. polyanthos* with large sori.

Hymenophyllum osmundoides is clearly of the group of *H. polyanthos,* and may represent that species, though it could not so well be *H. blumeanum* if they were to be distinguished. The lobes of its involucre are described as "triangularibus patulis, antice s. acutis, s. oblique truncatis, s. emarginatis;" on the type fragment they are elongate-triangular and very acute, as in some forms referable to *H. subdemissum.* Judging by this fragment, it is represented by a *Hooker and Thomson* specimen in the United States National Herbarium, probably a cotype. Like this are *Mann s. n.* from Assam, *Matthew s. n.* and *Dalziel s. n.* from South China, *Cavelerie 1326,* and *Pételot 411* and *3912* from Indo-China. *Chevalier 30904* is similar but depauperate. *Chevalier 30902* is *H. blumeanum.*

Hymenophyllum sphaerocarpum is otherwise similar, but has involucres circular in outline on contracted fertile segments. The Gray Herbarium contains a probably cotype, *Hooker and Thomson s. n.*—doubtful because of the absence of any collector's number, and a lower stated altitude. Like it are *Hooker and Thomson 332, Clarke 44739,* from Khasia; *Clarke 36429,* from Sikkim, is similar except that the sori are along the main rachis; *Kanehira and Sasaki 21658* can represent this or the ill-distinguishable *H. punctisorum.*

None of the foregoing have the dentate-thickened marginal walls of *H. blumeanum.* The material being too limited for really final judgment, I leave these "species" at peace; but more ample material may show them to be locally well defined.

Hymenophyllum microsorum was accepted by Hooker and Baker, Synopsis 59, as a species "Intermediate in habit between *H. exsertum* and *H. polyanthos.*" I cannot distinguish it by description from *H. blumeanum,* but the type fragment has somewhat broader laciniæ. Even this distinction does not hold with specimens from Burma, *Rock 7396,* and Yunnan, *Hancock,* identified by Christensen as *H. microsorum,* but with the previous avowal, op. cit. (1924) 50, that the species is not distinct. Other specimens are *Levinge* from Sikkim; *Eberhardt,* and *Pételot 583* from Tonkin. The marginal walls are characteristically (that is, in the manner of *H. blumeanum*) thickened. Beddome wrote

the name of this fern *H. microglossum*, in error, and was also confused in ascribing its type locality to southern India instead of to Sikkim.

Hymenophyllum microchilum (Baker) C. Chr. was described from Mount Kinabalu, from which type locality I have *Clemens 27070* identified by Christensen after he knew the type, *Haviland 1478*, in Kew. Other specimens in hand are *Clemens 31145* from the type locality, and *Clemens 20738* from Sarawak. Christensen cites specimens from all parts of Borneo. On *Clemens 27070* are involucres cut from less than a quarter to more than half of the way down (usually about one-third), with the lips varying from obtusely triangular to very broadly rounded. The extreme shortness of lip (less than one-fourth the length of the involucre) is matched by several Tahiti specimens, which, like those of Borneo, have the marginal walls, at least in part, toothed on the inside, as in *H. blumeanum*. The range in frond form is that familiar in *H. blumeanum*, *Clemens 20738* having the narrow form. If this species has really and normally an exserted receptacle, it is probably not even a near relative of *H. polyanthos;* but the specimens I have cited have very slender receptacles definitely shorter than the involucre.

I cannot distinguish *H. microchilum* specifically by the short lips, because on the individual frond their length varies to that of typical *H. blumeanum*—cleft halfway down.

Also from Kinabalu, *Clemens 40984*, comes a specimen which exhibits the other extreme of involucre, cleft actually to below the base(!), because it is not winged at all, and the base is retuse or subcordate, the vein becoming the receptacle at a point above the rest of the basal line. In any other group, extremes as conspicuous as this and *H. microchilum* would hardly be questioned as representing distinct species.

Hymenophyllum subdemissum was later construed by its own author, Philip. Journ. Sci. § C 2 (1907) 155, as *H. pycnocarpum*. In my opinion, it is endemic in the Philippines, with larger sori than *H. pycnocarpum*, the valves pointed, and longer than broad. Although typical *H. blumeanum* is found throughout the Philippines, it and *H. subdemissum* do not intergrade nearly as perfectly as do *H. blumianum* and *H. pycnocarpum* in Java. Neither does typical *H. pycnocarpum* have as acute valves as *H. subdemissum;* but in this respect some specimens from Sumatra (for example, *Matthew 666*) are like those of the Philippines. Philippine specimens are: *Cuming 364; Bur. Sci. 9807, 29702, 40629, 41905, 41988, 76538, 76549, 76555 part, 77216, 77217,*

78697, 80349; For. Bu. 4464, 7955; Whitford 922; Merrill 7141, 6919; Elmer 8362, 10230, 18014. In Negros and Mindanao the valves tend to elongate: examples, *Merrill 6917, 6948, Banks s. n.* from Negros; *Bur. Sci. 14773, 83462* from Mindanao. The valves may be fully twice as long as broad, with a very sharp point. In the same region occur plants with the valves elongate but rounded. The range is throughout the Philippines, except Palawan; and *H. blumeanum* has the same Philippine range. Of specimens known to me from elsewhere, the most similar are those already cited as *H. osmundoides.*

Hymenophyllum constrictum Hayata, non Christ, as described, is a local derivative of *H. blumeanum,* from the broad form of which it differs in being still broader and more dissected, and in the conspicuous constriction of the fertile segment immediately below the sorus. The cells are large, with very thin, even walls. The receptacle is cylindrical, about two-thirds as long as the involucre, with evident sporangiophores. The involucre may be round, or somewhat narrower or wider. I have not seen the type collection, but I have *Faurie 629* in the Phil. Nat. Herb., received without name, and *Kanehira 21658* in U. S. Nat. Herb., as *H. blumeanum,* both from Mount Arisan, the type locality. Other specimens are *Baker 14, Hancock 9* at least in part, and *Hayata* and *Sasaki,* from Formosa; *Loher 1199,* from Luzon.

By Hayata's figure and description, this would appear to be a distinct enough local daughter species, wanting only a tenable name. This name was provided the next year—*H. punctisorum,* described independently from the same mountain, Arisan—but this occupies the gap between *H. constrictum* Hayata and *H. blumeanum.* Faurie's specimen already cited is ample, and its fronds blanket *H. constrictum* and *H. punctisorum.* There are similar Chinese specimens, probably *H. sphaerocarpum,* from which the Formosa plant is hardly distinguishable.

I have no authentic specimen of *H. parallelocarpum,* and follow Nakai, Bot. Mag. Tokyo 40 (1926) 248, who reduced it to *H. blumeanum.*

In publishing *H. fujisanense,* Nakai cites several collectors but no numbers, so that I may or may not have any of the cited collections. He distinguishes it from what he calls *H. integrum* solely by the narrow frond, which, in this group, is usually no distinction at all.

Hymenophyllum pantotactum v. A. van Rosenburgh is described as "frondes . . . angustissimae lanceolatae, latissimae

deltoideae et ad basin latissimae," and as about as variable in other respects. I have not seen the type collection, but find nothing in the description to exclude it even varietally from *H. blumeanum*. *Palmer and Bryant 629*, from Mount Salak, altitude 1,600 m, where *H. blumeanum* in various forms is common, has one frond 30 cm long by 4 cm wide, and one 13 cm long by 10 cm wide, deltoid in outline, beside others of more common shapes.

The plant of the Society Islands, represented by *Vesco s. n.*, *Brackenridge* (as *H. gracile*), *MacDaniels 1553*, and *Grant 3562, 3728, 4221, 4492*, and *4982*, distributed partly without name, partly as *H. dilatatum*, usually has the involucre cleft one-third to half of the way down, with apparent vein branches subtending it; marginal walls toothed on the inside in some places, in others not so. The *Vesco* specimen resembles *H. blumeanum* in aspects, and is possibly the collection referred to by van den Bosch, Hymen. Javan. 47, 48 (*Vieillard and Pancher*), which is not in his herbarium. The recent collections are green, not brownish. The sori are wider than the segments. They are characterized by irregular length of pinnæ and especial width of the pinnules adjoining the rachis—tendencies of this species in other lands.

With the specimens just cited in hand, four years ago I described *H. gracilius*, based on *Grant 3766*, as distinct, characterized by the involucre cut halfway down (or a little farther), narrower segments and wing, and fertile segments contracted below the sorus. None of these distinguishes it from forms of *H. polyanthos* common elsewhere; and my present belief is that when it is collected again, there will be found also intermediate forms between it and its local relatives. This opinion applies also to *H. epiphyticum* Moore, the only peculiar feature of which is its winged stipe. It assumes the brownish color common in *H. polyanthos*.

Besides these named forms and varieties, there are others fully as worthy of name. *Hymenophyllum blumeanum* var. *novoguineense* Rosenstock, *Warner 49 a*, from Mount Gelu, well developed, is superficially less like *H. polyanthos*, or *H. blumeanum*, than is any form I reduce to synonymy. The cotype in Herb. Univ. Calif. bears two fronds over 45 cm long excluding stipes of 10 and 14 cm; one is 5, the other 10 cm wide. It has pinnæ up to 10 cm long. By size alone, it is a better "species" than most that I reduce. Besides the type collection, which in

U. S. Nat. Herb. is *Rosenstock Fil. Novoguin. Exsic. 55,* we have it as *205* of that series and as *Bamler 50 p,* from the Sattelberg, *Schlechter 16496,* and *v. Leeuwen 9185, 10129, 10320,* and *10368.* All the rest of these are variously intermediate between the type and ordinary *H. blumeanum,* which is represented by *v. Leeuwen 9467.* Nearly all of these are ample collections, with some fronds unmistakably representing the variety, others passable as *H. blumeanum.* Now, typical var. *novoguineense,* by itself, is different enough from *H. blumeanum* almost to demand specific recognition. The other collections cited may be presumed to be capable, genetically, of the same development. The mere capacity to develop in a characteristic manner may be a good specific character; it is a very familiar generic character in mycology. However, I leave it as a variety, both because it is only an assumption that the intermediates might develop further, and because, as a matter of convenience, the idea of two species in the same area, but sometimes indistinguishable, is abhorrent.

There are in the southern Philippines, besides typical *H. blumeanum,* small ferns much like it, but with large, broad lips, the involucre subtended by conspicuous apparent branches of the vein; *Bur. Sci. 44504,* from Tawitawi, is the best example. I give these on the labels the epithet *pseudorarum. Singapore field No. 10275,* from Kelantan, is similar. *Hymenophyllum rarum* is credited to Ceylon by Hooker, Sp. Fil. 1: 101, but not in later works by the same school (Baker, Beddome), and this seems to be due to renaming the specimens as *H. polyanthos* or *H. blumeanum. Herb. Lugd.-Bat. 908, 282–671* is from Herb. Hooker as *H. rarum,* determined as *H. blumeanum* by Rosenstock. It has the dilated fertile segments characteristic of *H. rarum.* I suppose that it is an aberrant *H. blumeanum,* another *pseudorarum;* but it remains possible that Hooker named it correctly.

Wherever *H. blumeanum* occurs the environment may effect dwarfing, most conspicuous, of course, when it operates in this way on a form or strain naturally small. The most extreme example I have seen is *Bur. Sci. 16661,* from Luzon, with freely fertile fronds 15 mm long, stipe included, Plate 47, fig. 7. The largest fronds of the collection measure less than 3 cm. I describe another dwarf as a distinct species, because it is changed in other ways as well as in size.

Notably slender fronds are occasionally found almost anywhere. *Brooks 162,* from Sarawak, measures, stipe excluded, 23 cm by 18 mm. Ceylon plants seem mostly to be slender—

for example, *Thwaites 1391; Moon 63* is slender but with un-uniform pinnæ.

From Africa (*Stoudt 370*) to Australia very lax fronds are occasionally found. The most extreme of these is from Camiguin de Mindanao, *Bur. Sci. 14845*, Plate 47, fig. 6, which I illustrate because written description would hardly make it credible.

In Mauritius this would be *H. gracile*, which, if it were found only in Mauritius, I would regard as a local species. When, however, we have substantially the same form from the Philippines and from Kamerun (*Staudt 370, Zenker 3880*), the practical alternatives are to try to recognize two, or three, or more indistinguishable local species, or to construe them all as *H. polyanthos*. We have the evidence in form of intermediates that the Philippine form is of local origin and not well fixed. Single Mauritius collections (old Kew distributions in Herb. Lugd.-Bat.; *Mrs. Pike* in U. S. Nat. Herb.) show that *H. gracile* in its type locality may have straight or zigzag rachises, and is as variable as aberrant forms are prone to be, in laxness, in width of pinnæ, and in size of involucre.

Hymenophyllum inaequale, to which *H. gracile* has long been reduced, is known to me by two collections, *Hildebrand 3778*, and *Humbert 3504*. These are two of three Madagascar specimens, all alike, known to Christensen, Dansk bot. Arkiv 7 (1932) 11, who finds them so near to *H. polyanthos* that he doubts the correctness of the identification and questions the occurrence of *H. inaequale* in Madagascar. They agree very well with Poiret's description; and Madagascar is the stated source of the type. They are not nearly as distinct a form as is *H. gracile*, and I do not hesitate to include them in *H. polyanthos*.

I have already noted that from the Himalayas to Japan specimens are present which represent *H. polyanthos*, but not any Old World form which I reduce to that species; I do not cite specimens because most are without collectors' numbers. Among these, however, *Wallich 172* must be discussed, because, as it is recognized as *H. polyanthos* by Hooker, Sp. Fil 1: 102, I see no reason to doubt that it is *H. tenellum* Don, which Hooker listed, page 112, as a "dubious species." This species was published with citation of collections, without numbers, by Hamilton and Wallich, from Nepal. Van den Bosch, Synopsis 51, preserved it, citing without number "Wall. (spec. ex dono, Lambert in Herb. Sond.)" His unpublished manuscript in Herb. Lugd.-Bat. *910.38–106* shows that he saw the collections of both Hamilton and Wallich in the Herb. Sonder, and that *Wallich 172* in the

Herb. Hooker is the same. His description and sketches, and the fragment in his herbarium, permit no question that it is what I construe as fairly typical *H. polyanthos*.

The following collections are cited to authenticate the specimens and places: Fiji, *Parks 20769*. Samoa, *Whitmee, Powell, Betche; Reinecke 62, 175*. Marquesas, *Mumford* and *Adamson 360*, with broader segments than typical.

Great as is the range of forms assembled here as one species, there are evident trends within which the variability is manifested in one after another of the described species. The presence of almost linear and of broadly lanceolate or even ovate fronds is known in almost all of them—in all which have been freely collected, unless the narrow form is "excluded" by definition. The broad form develops, of course, from the narrow by elongation of the pinnæ, and fronds of irregular form, with pinnæ of very unequal length, are found from Africa and Ceylon to Tahiti. With any tendency to laxness, the rachis is usually flanked by short, broad, flabellate acroscopic pinnules, giving the frond a more compact middle line. If laxness is considerable, whether because of few or of narrow segments, the rachis tends to be zigzag. There is a limited correlation between laxness and narrow and pointed involucre valves.

The reader will probably find my presentation of this species or group unsatisfactory; it is so to me. In so wide-spread and varied a group, it is usually possible to give some kind of definition to species of limited distribution, as with some limited success I have essayed to break up the group of *Trichomanes rigidum*, even if into species hard to distinguish if of unknown origin. *Hymenophyllum polyanthos* is more variable, and variable in more respects, convenient for definition. But, in repeated attempts to recognize and maintain species described and easily distinguished by their types, I have in every case been forced to conclude, if many specimens were available, that the "species" was not well defined even locally.

68. HYMENOPHYLLUM KUHNII Christensen. Plate 48.

Hymenophyllum kuhnii CHRISTENSEN, Index (1905) 363.

Hymenophyllum Meyeri KUHN, in Engler, Hochgebfl. Trop. Afrika (1892) 94, *non* Presl (1843).

Rhizomate elongato tenero; foliis membranaceis glaberrimis siccitate badiis; petiolo tenero terete; rhachi anguste alato-marginata, lamina elongato-lanceolata tripinnatipartita; laciniis primariis patentibus elongato-lanceolatis apice obtusis, secundariis trapezio-oblongis obtusis, ultimis paullo elongatis obtusis; soris lacinulas laterales internes occupantibus, lati-

tudine laciniarum statu evoluto latioribus basi manifeste immersis, labiis profunde divisis elongato-obtusis integerrimis, cruribus in basi manifestis, columella inclusa parva.

Foliorum petiolus 1–2 cm longus, lamina 10–50 cm longa, 2–6 cm lata. *Hymenophyllo sphaerocarpo* v. d. Bosch (Ned. Arch. V. 167) affine, sed soris elongatis et auribus in basi labiorum satis distinctum.

Kilimandscharo, im Urwald am Südabhang massenhaft von 1930–2800 m (v. Höhnel 146, 147, Ehlers n. 66); im oberen Urwald um 2500 m (H. Meyer Aug. (1881), am Ruabach, 1900–2300 m. Waldpfl. (H. Meyer 310).

I know this species by *Rosenstock, Fil. Agricae or. germ. exsic. 1, Daubenberger,* from Kilimanjaro, altitude 3,000 to 4,000 m, the type locality, in U. S. Nat. Herb., Herb. Univ. Calif., and Herb. Copeland. There is in Herb. Lugd.-Bat. *908, 282–296, Busse 271,* a sterile specimen bearing this name, not distinguishable from *H. polyanthos.* Neither can I distinguish the Daubenberger collection by the characters emphasized by Kuhn—sorus longer than in *H. sphaerocarpum,* which is true also (relatively) of typical *H. polyanthos,* and *cruribus* or *auribus* in the base of the involucre, equally conspicuous in the Philippine form which I call *pseudorarum.*

However, as represented by the fairly uniform Daubenberger collection, and as described, this species is larger than any form of *H. polyanthos* except var. *novoguineense,* peculiar enough in form, so that, considering also the apparent vascular branches (*cruribus*) subtending the involucre, it seems to constitute a well enough established local derivative to merit specific recognition. However, it is approached by other plants of the same region which I leave in *H. polyanthos* (*Last,* in U. S. Nat. Herb.).

The well developed fronds are about 30 cm long, including stipe, 2 to 3 cm, and 5 cm wide, linear-elliptic in outline, rachis slightly zigzag and very narrowly winged, pinnules quite uniform and the pinnæ therefore symmetrical, segments 0.7 to 1.2 mm wide, 2 to 4 mm long; walls, marginal and others, uniformly very thin; involucre orbicular or somewhat elongate, up to 1.2 mm wide, the apex broadly rounded or with an obscure point.

60. HYMENOPHYLLUM OOIDES F. von Müller and Baker.

Hymenophyllum ooides F. v. MÜLLER and BAKER, Journ. Bot. 23 (1890) 105.

Stipe short, thread-like, glabrous. Fronds lanceolate, 2–3-pinnate, pendulous, glabrous 6–9 in. long, at most an inch broad; rachis thread-like. Pinnae very numerous, lanceolate, ascending, those in the centre of the frond the largest, usually simply pinnate, rarely with small pinnate pinnules. Ultimate segments obovate, obtuse, 1-nerved, emarginate, crowded, about 1/12 in. long, more or less crisped and complicated. Sori small,

terminal on the ultimate segments. Indusium immersed at the base in the lamina of the segments, its valves cuneate with a rounded margin.— New Guinea highlands, alt. 9200 ft. A very distinct species, allied to *H. undulatum* and *crispum.*

Of this species I have *King 106,* a juvenile frond identified by Bailey, and *King 246,* fully developed. The former could pass as the linear form of *H. blumeanum.* The latter transcends it enough to merit specific recognition.

Stipe finely filiform, marginate in the upper part; frond 27 cm long, 3 cm wide at the middle, thence narrowed to both ends, rachis filiform, narrowly winged throughout; pinnæ close, ovate rather than lanceolate, their segments simple, or on the larger pinnæ once or twice dichotomously cleft; laminar tissue dark and nearly opaque because of the dark cell contents, walls thin, the marginal ones slightly, irregularly thickened; sori on distal, distal and acropetal, or all segments of the upper pinnæ, involucre up to 1.5 mm long and 0.9 mm wide, base immersed, lips rounded, entire; receptacle slender, included (the tip seen extruded in two sori).

Derived from *H. polyanthos.*

Known from eastern New Guinea only.

70. HYMENOPHYLLUM RECURVUM Gaudichaud. Plate 49.

Hymenophyllum recurvum GAUDICHAUD, in Freyc. Voy. Bot. (1827) 376.

H. frondibus bipinnatis (6–8-pollic.), pinnis elongato-recurvatis; pinnulis dichotomo-pinnatifidis; laciniis simplicibus; elongatis, integris; soris supra axillaribus, solitariis; indusiis ovatis; rhachi stipiteque alatis; caudice filiformi repente.

In insulis Sandwicensibus (Mowi. Alt. 500–550-hexap.).

L'*hymenophyllum recurvum* croît sur les montagnes élevées de l'île Mowi, au pied des plus grands arbres, parmi les mousses. Il est remarquable par la disposition recourbée de ses divisions supérieures, qui sont simples, linéaires souvent trés-alongées; ce que donne à cette petite plante l'aspect d'un saule pleureur. Les fructifications sont solitaires, fort grosses, ovales, à tégumens entiers ou légèrement émarginés, libres dans presque toute leur longueur. Parmi les échantillons de cette fougère, glabre dans toutes ses parties excepté sur la tige, il s'en trouve quelque-uns non encore bien développés, écailleux, à écailles piliformes, capillaires, articulées, ce qui doit faire supposer ou que cette plante est velue dans sa grande jeunesse, ou qu'une espèce nouvelle, très-voisine de celle-ci, se rencontre dans la même localité. *Hymenophyllum* (aut *trichomanes*) *pilosum?*

Known on all the larger Hawaiian islands, and nowhere else.

Stipe, 1.5 to 8 (commonly 5) cm long, one-tenth to one-fourth the length of the frond; rachis and upper part of stipe narrowly winged, or merely marginate in the lower part; pinnæ, pinnules,

and segments usually remote on large fronds, which are therefore conspicuously lax, segments about 1.2 mm wide, hardly narrowed below the sori; lowest pinnæ usually reduced, the medial or supramedial ones often prolonged; sori on short, basal acropetal branches of the pinnules; involucre oblong to round, 1.3 to 2 mm wide, the margin usually entire; receptacle and sporangia included, the former fertile in its upper half, not at all enlarged, the sporangia practically sessile.

Although our material of Gaudichaud's collection has few sori, I have thought it best to use it for illustration.

71. **HYMENOPHYLLUM ANGULOSUM** Christ. Plate 50.

Hymenophyllum angulosum CHRIST, Philip. Journ. Sci. § C 3 (1908) 269.

Caespitosum, stipite rhachique inferiore ebeneis exalatis, fronde bi- et ad basin tripinnatifida, fronde sterili late flabellata, fertili elongata, laciniis elongatis divaricato-furcatis, marginibus laevibus integris, soris terminalibus, valvis crenatis, late ovatis.

Habitu *H. capillacei* Roxb., Ins. S. Helenae, et *H. inaequalis* Poir. Africae, sed minus, minusque compositum, laciniis latioribus.

Rhizomate caespitoso-repente filiformi, nigro, glabro uti tota planta, stipite 1.5 ad 3 cm longo stricto tenui ebeneo exalato, fronde sterili subflabellata 3 cm lato et longa, bi-, infra tripinnatifida, rhachi supra anguste alata nigra, pinnis 3 vel 4 utrinque cuneato-flabellatis, infimis 6-partitis superioribus tripartitis, laciniis ultimis 4 mm longis 1.5 mm latis obtusis linearibus diaphanis nervo nigro praeditis; fronde fertili ovato-oblonga basi attenuata, 7.5 cm longa, 3 cm lata, subtripinnatifida, pinnis 7 utrinque; fronde versus apicem acuminatum sorifera, soris in laciniis terminalibus, 1.5 mm latis, rotundato-ovatis, valvis crenato-denticulatis. Textura tenui, colore dilute fusco-virente.

MINDORO, Mount Halcon, *Merrill 6080*, November, 1906.

There is a second, identical collection from the same place, *Bur. Sci. 40555;* an earlier collection from Mount Banahao, *Whitford 919,* had been distributed partly unnamed, partly as *H. Treubii* in error; recent collections from Batan Island, north of Luzon, are *Bur. Sci. 80346* and *80348.* The range is thus Luzon and adjacent islands. *Merrill 6082,* from the type locality, larger and with protruding receptacles, has been taken for an aberrant *H. emarginatum,* but is more probably *H. angulosum.*

The plant is in no sense dimorphous, what Christ described as sterile fronds being dwarfed or juvenile. The segments are about 1 mm wide. The rachis is narrowly winged in the upper part, not at all in the lower. The Batan Island specimens are larger than typical, with filiform stipes up to 9 cm long, and fronds up to 11 cm long and 4 cm wide.

There is a superficial resemblance between this species and *H. Treubii,* both having small fronds and few segments, but the affinity is not close. *Hymenophyllum angulosum* may be a reduced relative of *H. emarginatum.*

72. HYMENOPHYLLUM PANICULIFLORUM Presl. Plate 51.

Hymenophyllum paniculiflorum PRESL, Hymen. (1843) 147; VAN DEN BOSCH, Hymen. Japan. 49, *pl. 39;* CHRIST, Philip. Journ. Sci. § C 2 (1907) 155.

Hymenophyllum coloratum Al. Br.: VAN DEN BOSCH, Pl. Jungh. 1 (1856) 565, *teste* van den Bosch, Ned. Kruid. Arch. 5^3 (1863) 198.

Hymenophyllum discosum CHRIST, Bull. Boiss. 6 (1898) 140.

H. glaberrimum, fronde ovata obtusa, tripinnata, pinnis petiolulatis ovatis obtusis, pinnulis primariis lanceolatis obtusis, secundariis linearibus indivisis obsolete emarginatis integerrimis, stipite basi tereti apice rachibusque alato, soris in apice frondis paniculatis, indusii usque fere ad basim bifidi laciniis orbiculatis receptaculum superantibus.
Cuming pl. philip. exs. n. 214.

Habitat in insulis Philippinis, verosimiliter in insula Luzon, ubi legit clar. H. Cuming.

Rhizoma ignotum. Herbula glaberrima. Stipes semipollicaris, subflexuosus, fuscus, filiformis, inferne teres nudus, apice alatus, ala integerrima. Frons seu frondis limbus sesquipollicem longa, pollicem lata, ovata, utrinque obtusa, tripinnata, exsiccata purpurascens. Pinnae alternae, petiolulo semilineali instructae, ovatae aut ovato-lanceolatae, obtusae. Pinnulae primariae lanceolatae, obtusae, basi acutae, secundariae lineares, indivisae, obtusae, apice laeviter aut non emarginatae, integerrimae, planae. Rhaches petiolulique alatae, ala integerrima. Venae simplices, fuscescentes, apice liberae. Parenchyma e cellulis hexagonoideo-subrotundis constructum. Sori in pinnis terminalibus omnibus fructiferis paniculae terminalis in modum dispositi, apicales, sessiles in pinnis pinnulisque reliquis angustioribus. Indusium tres quartas lineae partes longum, usque fere ad basim bifidum, laciniis orbiculatis adpressis disco convexis integerrimis. Receptaculum indusio triente brevius, cylindricum, obtusum, undique capsuliferum. Capsulae lenticulares, sessiles.

Vidi solummodo duo specimina, unum sterile parvulum, alterum fertile supra descriptum. An omnia specimina fertilia soros in panicular terminalem dispositos gerunt? Species caeterum distinctissima.—PRESL, loc. cit.

A small plant recognizable by its large sori which are ovoid or globose, terminal and occupying all the segments at the summit of the frond.

LUZON, Province of Benguet, Mount Tonglon, 2,250 m. alt. (*Loher*) April, 1904. Identical with specimens from Java, leg. *Giesenhagen* and *Raciborski,* and with specimens from Japan, leg. *Faurie.*

I am now of the opinion that *H. discosum* Christ, Bull. Herb. Boiss. 6 (1898) 140, should be united with this species, although the sori are much broader and more round than those in the Javan Plant, leg. *Giesenhagen.*—CHRIST, Philip. Journ. Sci. § C 2 (1907) 155.

Frond commonly 5 cm or less long, ovate, with uniformly narrowly winged rachis, and ultimate segments a scant half-millimeter wide; sori of fully fruiting fronds terminating all segments of the upper third or half of the frond; involucre divided nearly to the base, with ovate to orbicular entire valves, fully twice as wide as the segments, or still wider; receptacle cylindrical, without conspicuous sporangiophores.

The walls between the laminar cells are uniformly thin. The marginal wall of our cotype is uniformly very thin in some places, slightly and irregularly thickened in others. In some Philippine specimens it is very evidently toothed, although less remarkably so than in van den Bosch's figure, Hymen. Javan. pl. 39, fig. 7.

A relative of *H. pycnocarpum*, well distinguished by the wider segments and sori, and the absence of sterile segments in the upper part of fruiting fronds. The color is usually a brownish green, less brown than is usual with *H. blumeanum.*

Hymenophyllum discosum as described would perhaps be distinguished by round, instead of ovate involucres. Both forms occur both in Java and in the Philippines; they are ovate on our Philippine cotype. If there is any difference between Javan and Philippine specimens, it is that the former have the rachis more narrowly winged, sometimes apparently wingless at the base.

Inconspicuous, but not rare on high mountains in Benguet, Luzon. Philippine collections: LUZON, locality unknown, *Cuming 214* (cotype in Phil. Nat. Herb.), (*Loher,* type of *H. discosum*); Bontoc Subprovince, Bauco, *Vanoverbergh 1757:* Benguet Subprovince, Mount Pulog, *F. B. 16316 Curran, Merritt, and Zschokke, 11070 Whitford, Merrill 6373, 6374, 6386, Bur. Sci. 44885 Ramos and Edaño;* Haight's Place, *Bur. Sci. 4235, 4236 Mearns:* Zambales Province, Mount Pinatubo, *Bur. Sci. 2550 Foxworthy.* MINDANAO, Bukidnon Province, Mount Lipa, *Bur. Sci. 38565 Ramos and Edaño.* NEGROS, *Merrill 6917* in Herb. Lugd.-Bat. *nec alibi.* Apparently rare in Java, where van den Bosch cited only a collection by Al. Braun. There are several sheets in Herb. Lugd.-Bat. ex Herb. Waitz. More recently collected on the Gedeh-Pangrango, *Raciborski, Copeland,* and *Yates 2826.* BORNEO, Mount Kinabalu, *Clemens 51543* (also *teste* Christensen and Holttum, Gardens' Bull. 7 (1934) 213, *Holttum 25497, Clemens 28014*). So far as I have seen specimens from Japan, China, *et alibi,* bearing this name, I believe that it is incorrect.

73. HYMENOPHYLLUM NITIDULOIDES Copeland sp. nov. Plate 52.

Rhizomate intricato, vix ultra 0.1 mm crasso, obscuro, glabrescente; stipite tenuissimo, 1 ad 2 cm alto, terete, nudo; fronde 15 ad 25 mm longa, forma varia, nunc subflabellata, nunc pinnatifida segmentis furcatis, glabra, costis ubique alatis; segmentis usque ad 8 mm longis, 1 ad 1.5 mm latis, integris; parietibus marginalibus plerumque dentibus obtusis incurrentibus praeditis, internalibus diaphanis, huc molliter illuc irregulariter subincrassatis; soris segmenta (infimis exceptis) terminantibus, involucro orbiculare basi late cuneata immerso, adhuc bilabiato labiis integris rotundatis, receptaculo breve, cylindrico.

LUZON, Sorsogon Province, *Bur. Sci. 23577 Ramos,* September 9, 1915 (type in Phil. Nat. Herb.).

This is a dwarf derivative of *H. polyanthos,* so changed in aspect with the reduction in size that its specific distinction is expedient. It has remained two decades in the herbarium, without a suspicion as to its affinity, annotated as "*Microtrichomanes.*"

74. HYMENOPHYLLUM SANGUINOLENTUM (Forster) Swartz. Plate 53.

Hymenophyllum sanguinolentum (Forster) SWARTZ, Schrad. Journ. 1800[2] (1801) 101 (not seen); Synopsis 148, 376; SCHKUHR, Krypt. Gew. 136, *pl. 135 c;* HOLLOWAY, Trans. N. Z. Inst. 54 (1923) 588, *pl. 57.*

Trichomanes sanguinolentum FORSTER, Prodromus (1786) 84.

Sphaerocionium sanguinolentum PRESL, Hymen. (1843) 35.

Mecodium sanguinolentum PRESL, Epim. (1849) 258.

Hymenophyllum polyanthos HOOKER, Sp. Fil. 1: 107, *part., non* Swartz.

H. lophocarpum COLENSO, Trans. N. Z. Inst. 17 (1884) 255.

Hymenophyllum cristulatum ROSENSTOCK, Fedde's Repert. 5 (1908) 14.

T. sanguinolentum, frondibus subbipinnatis, foliolis alternis pinnatifidis: pinnis dichotomis lineari-oblongis obtusis integris decurrentibus: fructificationibus ovato-subrotundis dehiscentibus. F.

Nova Zeelandia.—FORSTER, loc. cit.

Stipe one-third to half as long as the lamina, terete, nearly black; lamina commonly 10 cm long but sometimes fully fertile 5 cm long, usually ovate but varying from lanceolate to deltoid, base contracted or broad, dark, compact, usually tripinnatifid, but secondary pinnules sometimes forked, segments 1 mm wide, 3 to 4 mm long; rachis narrowly winged with raised edges, or sometimes wingless near the base; marginal walls thin in some places, coarsely dentate-thickened in others; other walls thin; sori winged at base only, involucre cleft to the wing, 1.5 mm wide, ovate or broader or oblong, margin usually quite entire;

receptacle included, cylindrical, with inconspicuous sporangiophores.

The involucre is remarkable, unique in its group, in that it may bear thickenings or crests on the outside near the base, such as are characteristic of the groups of *H. denticulatum* and *H. fuscum*. These were known to Hooker, Sp. Fil. 1: 107; "in one of Dr. Logan's specimens the involucres have crested lamellae." In the unpublished notes of van den Bosch I find "lobis" [indusii] dors. irregulariter gibberosis vel appendiculatis." Some such sori can be found on many or most specimens if they are sought with sufficient care. The outgrowths vary from apparently absent, to evident on all sori, as in the case of *Ranfft 1, Rosenstock Fil. Novae-Zeal. 11,* the type collection of *H. cristulatum*. Of specimens in hand, the most conspicuous in this respect is *Brame s. n., U. S. Nat. Herb. 1371318*. The suggestion obtrudes itself that we are dealing here with a hybrid of *H. denticulatum* and an original *H. sanguinolentum* or *H. polyanthos* with smooth involucre.

Apparently common in New Zealand. As the many specimens are correctly named, or named *H. polyanthos* which is not found in New Zealand, citation is unnecessary. The only very aberrant one in hand is *Kirk 561* in U. S. Nat. Herb., with a frond 30 cm long, and a pinna 14 cm long by 15 mm wide, recalling *H. blumeanum novoguineense*.

This species is related to *H. polyanthos*, which it represents in New Zealand, and from which in general it is distinguished by a blackish stipe, darker fronds, raised margin of wing of rachis, and larger or at least wider sori. Its most distinctive character is the odor, strong on all herbarium specimens less than 30 years old, and evident after more than 80 years.

75. HYMENOPHYLLUM PRODUCTUM Kunze. Plate 54.

Hymenophyllum productum KUNZE, Bot. Zeit. 6 (1848) 305; VAN DEN BOSCH, Hymen. Javan. 56, *pl. 45*.

Hymenophyllum demissum, partim, auct. mult., non Swartz.

Fronde subcoriacea, tenui, olivacea, pellucente, fusco-nervosa, ovato-oblonga, acuminata, curvato-flexuosa, basi in stipite décurrente, subbipinnato-pinnatifida; pinnis patenti-erectis, trapexo-ovato-oblongis, oblongisve, acuminatis, in rhachi alata decurrentibus; pinnulis cuneato-obovatis s. oblongis, irregulariter incisis, sinubus obtusis; laciniis furcatis, lacinulis lineari-oblongis, integerrimis, apice subdenticulatis; sterilibus retusis emarginatisve, inferioribus sorophoris; involucris basi brevi, subcuneata immersis, labiis magnis, liberis, ovato-acuminatis, obtusis, margine serrulato-laceris; receptaculo cylindrico; immerso; rhachibus flexuosis, alatis; stipite brevi, filiformi,

scabro; caudice filiformi, subramoso, repente, sparsim minutissime paleaceo, radiculoso.—KUNZE, loc. cit.

The first citation is a number *74;* the second is *Zollinger 363;* of old collections, I have seen *Zollinger 43, 57,* and *363,* and *v. Gesker* in Herb. Zollinger, from Mounts Salak and Gedeh. The description by van den Bosch, based mostly on the same collections, is much better.

Stipe commonly 5 cm long, firm, with an attenuate wing half or two-thirds of the way down; frond 10 to 18 cm long, 4 to 7 cm wide, tripinnatifid in ample forms, all axes winged; pinnæ very oblique at base, ovate or narrower, acuminate, usually not imbricate; all divisions divaricate, with rounded sinuses, the frond therefore distinctly lax in appearance; margin entire except that the apices of sterile segments, when not notched, are often minutely toothed; cell walls uniformly thin; sori very abundant, on any or almost all segments, winged only at the very base, where the fertile segment is sometimes constricted; involucre narrowly ovate or narrower, sometimes broad at the base, cleft to the very short wing, valves minutely and irregularly toothed in the upper part, the apex usually narrowly rounded, sometimes acute or apiculate; receptacle narrowly cylindrical with conspicuous sporangiophores. The sinuses are not merely broadly rounded, but also usually overfull, the margin thereby depressed out of the plane of the frond.

This is one of the best defined Malayan species, and is so unlike the *H. demissum* of New Zealand that their confusion is inexplicable.

JAVA, many collections. SUMATRA, *Korthals, Waitz, Lorzing 6770, Winkler 162.* BORNEO, *Korthals, Clemens 28228, 40900.* LUZON, Laguna Province, San Antonio, *Bur. Sci. 12080 Ramos:* Tayabas Province, Mount Pular, *Bur. Sci. 19394 Ramos.* CATANDUANES, *Bur. Sci. 30386, 30571 Ramos.* NEGROS, *Elmer 10426.*

75a. HYMENOPHYLLUM TODJAMBUENSE G. Kjellb.

Hymenophyllum todjambuense G. KJELLB., Bot. Jahrb. 66 (1933) 41.

Nr. 3505, Todjamboe 1000 m, Epiphytisch im Regenwald [Celebes].

Rhizoma filiforme, nudum. Stipites 2–3 cm longi, circ. ± 2 cm distantes, non alati. Folia lanceolata, ± 10 cm longa 2 cm lata, luteo-viridia, utrinque ad 8-nim pinnata; pinnulae 3–4, apice emarginatae; earum breviores apice soriferae. Rhachis alata, ala sursum dilatata. Venae secundariae fuscae, sinum apicalem haud attingentes. Indusium ovale. Cellulae folii hexangulae.

Diese Art steht *H. productum* Kze. nahe, unterscheidet sich aber durch die weniger verzweigten Pinnae, spärlicheren Sori, den nicht geflügelten Stipes und das Indusium.

76. HYMENOPHYLLUM REINWARDTII van den Bosch. Plate 55.

Hymenophyllum Reinwardtii VAN DEN BOSCH, Plant. Jungh. 1 (1856) 567 (not seen), Synopsis 59; Hymen. Javan. (1861) 52, *pl. 42.*

Hymenophyllum dichotomum BLUME, Enum. (1828) 222, *non* Cavanilles.

Hymenophyllum australe CHRIST, Philip. Journ. Sci. § C 2 (1907) 156; COPELAND, Elmer's Leaflets 3 (1910) 800, *non* Willd.

Hymenophyllum australe var. *elongata* ROSENSTOCK, in Herb. Lugd.-Bot., *Koorders 17028.*

Hymenophyllum Copelandianum V. A. VAN ROSENBURGH, Bull. Jard. Bot. Buitenzorg II No. 7 (1912) 19.

Fronde olivaceo-viridi lanceolata vel ovata apice producta tripinnatifida, laciniis patulis vel divergenti-deflexis, fertilibus remotiusculis, ovatis plus minusve elongato-acuminatis, lacinulis elongatis undulato-crispis sinuato-denticulatis, e cellulis diaphano-hyalinis sub-elongatis obtusangulis laete viridibus contexta, soris in lacinulis abbreviatis lateralibus vel subaxillaribus magnis suborbicularibus compressis ad basin breviter alatam usque bilobis, lobis denticulatis, receptaculo indusium dimidium aequante, rhachide stipiteque frondem longitudine aequante, excepta basi, ala latiuscula undulata denticulata marginatis.

Hab. in sylvis elatioribus insulae Tidore Moluccarum, *Reinwardt;* Java? Herb. Reg. L. B.—VAN DEN BOSCH, Hymen. Javan.

The description and illustration of this species by van den Bosch are below his standard. The Herbarium Lugduno-Batavum contains three sheets collected by Reinwardt in Tidore and two purporting to be from Java, all from Blume's herbarium. They are so perfectly alike that I concur in the suspicion of van den Bosch they are one collection.

Rhizome 0.7 mm thick, brown, woody, naked in age; stipe 10 cm long, 1 mm thick, winged except near the base; stipe and rachis scurfy with fine, appressed, sometimes deciduous pubescence; frond 15 cm long, ovate, subquadripinnatifid; all axes bearing crisped wings, major ones 1.5 mm wide, overall; segments 0.7 mm wide, 2 to 3 mm long; margin everywhere inconspicuously serrulate; walls all thin, slightly wavy; fertile segments usually somewhat contracted; involucre more or less orbicular, 1 to 1.2 mm wide, cleft to the base, lips entire or sometimes wavy or obscurely toothed, receptacle with columnar sterile base reaching to middle of involucre and a very slightly enlarged head on and around which the sporangia are densely borne.

Specimens: SUMATRA, *Bünnemeyer 9762, 9826.* JAVA, doubtful. TIDORE, type collections by *Reinwardt* in 1821. CELEBES, *Koorders 17028.* MINDANAO, *DeVore and Hoover 324, Copeland 1024, 1441, Williams 2496 bis, Elmer 11799* (type of *H. copelandianum*). LUZON, *Copeland 1873* (as to which, *i. a.*, Christ wrote of *H. australe:* "The Philippine form has very narrow

segments and is very compound, quadripinnatifid. Under the lens the margins are very finely denticulate."), *F. B. 16317, Bur. Sci. 44916, 44918, 48568, Topping 1139, 1147.* Reported from Dutch Borneo, from which I have seen no specimen; and from New Guinea. As to the latter, *Lam 1782* (sterile) seems misdetermined as this species. *King 210* is possibly *H. Reinwardtii*, but is distinctly smaller (7.5 cm long), and much more crisped, and more spiny, Philip. Journ. Sci. § C 6 (1911) 69.

The Tidore and Mindanao specimens are quite alike; those from Luzon and Sumatra inconsiderably different. A specimen from Leyte, *Bur. Sci. 14481*, is fairly intermediate between *H. Reinwardtii* and *H. fimbriatum.*

77. **HYMENOPHYLLUM THUIDIUM** Harrington. Plate 56.

Hymenophyllum thuidium HARRINGTON, Journ. Linn. Soc. Bot. 16 (1877) 25; CHRIST, Philip. Journ. Sci. § C 2 (1907) 154.

Hymenophyllum physocarpum CHRIST, in Schum. and Laut., Nachtr. Fl. deut. Schutzgeb. (1905) 35, *pl. 1.*

Stipe slender, 1–3 inches high, winged, (frond) from 2–5 in. long, 1–2 in. broad, ovate to oblong, tri- or quadripinnate, erect; rachis and branches winged like the stipe; pinnae 1 in. long or less, deltoid; wing and ultimate divisions of lamina finely crisped thruout; surface glabrous; sori few to many on the upper part of the frond, at the ends of the ultimate divisions, large; involucre divided nearly to the base; valves large, ovate, crisped.

Mountains of Panay, Philippines, growing thickly on the trunks of trees. The finely crisped wing and margin of the pinnae give the plant a resemblance to some of the mosses; hence the name assigned to it. The margins are sometimes denticulate; and exceptionally pubescence is present. The plant has affinity with *H. tortuosum*, Hooker; but is nearer *H. crispum*, H. B. K.—HARRINGTON, loc. cit.

There are cotypes in U. S. Nat. Herb. and Gray Herb., and I have a type fragment from the University of Michigan. MINDANAO, *Copeland 1731* from San Ramon, Zamboanga, is almost typical; *Bur. Sci. 39086* from Bukidnon, central Mindanao, is somewhat less crisped, thus approaching *H. Reinwardtii.* NEW GUINEA, *Rosenstock Fil. novoguin., exsicc. 206. l. Bamler.*

The involucre is 1 to 1.4 mm wide, more than twice the width of the segments. The lips of the type vary from entire to obscurely toothed. They are more toothed on the San Ramon specimen, approximately entire on the Bukidnon one. The receptacle is as in *H. Reinwardtii*, with sterile columnar base and slightly enlarged head bearing a compact compressed globe of sporangia—compressed by the valves. The stipe is winged to the base or nearly so. It and the lower part of the rachis may

be 1 mm wide, overall. The minor axes and segments are a scant 0.5 mm wide. The crisping is so intense that careful examination is required to show that, besides the apparent teeth due to the crisping, the margin is really somewhat dentate.

Hymenophyllum physocarpum is represented in Herb. Univ. Calif. by the Bamler collection already cited (the type was collected by Schlechter), which conforms perfectly to Christ's description. It is hardly as closely crisped as the type of *H. thuidium,* but conforms perfectly to Mindanao specimens. The resemblance to *H. sabinifolium,* with which Christ compared it, is superficial.

Closely related to *H. Reinwardtii;* distinguished by the much more intense crispiness and narrower segments.

77a. **HYMENOPHYLLUM BISMARCKIANUM** Christ.

Hymenophyllum Bismarckianum CHRIST, in Schum. and Laut., Nachtr. Fl. deut. Schutzgeb. in der Südsee (1905) 34.

A H. denticulato Sw. differt magnitudine triplo majori, soris non axillaribus sed terminalibus in lobis pinnularum, rotundatis, minutis, atrofuscis, valvis integris, haud spinosis.

Kaiser-Wilhelmsland: Bismarck-Gebirge, 1800 m. ü. M. (Schlechter n. 14030, im Januar 1902).—CHRIST, loc. cit.

Bamler 230a in Herb. Univ. Calif. bears this name, but is so unlike anything this description suggests that I suspect misplacing of label rather than error in identification. Christ, Philip. Journ. Sci. § C 2 (1907) 154, compares this with *H. thuidium,* apparently suggesting that they are identical. I would rather expect it to be *H. Reinwardtii,* except for the entire valves.

78. **HYMENOPHYLLUM SAMOENSE** Baker. Plate 57.

Hymenophyllum samoense BAKER, Journ. of Bot. (1876) 10; CHRIST, Engler's Jahrb. 23 (1896) 338.

H. shirleyanum DOMIN, Bibl. Bot. 20 fasc. 85 (1913) 22, pl. 1, fig. 1, *pl. 2, fig. 1.*

Hymenophyllum australe COPELAND, Bishop Mus. Bull. 59 (1929) 29, *non* Willd.

Hymenophyllum fucoides CHRIST, Engler's Jahrb. 23 (1896) 337, *non* Swartz.

Rhizome wide-creeping, 0.5 mm thick, brown, glabrescent; stipe about 5 cm long, winged almost to the base; frond about 10 cm long, ovate, naked, tripinnatifid with some segments again forked, rachis narrowly winged with a plane or slightly crisped entire wing, segments 5 to 8 mm long, 1 mm wide, obscurely serrulate or in considerable part entire; cell walls uniformly thin, straight or curved, the marginal teeth usually of

a single cell, at most two cells wide; sori axial to subterminal on somewhat shortened segments, involucre cleft practically to the base, lips irregularly denticulate, receptacle included.

Specimens: SAMOA, *Whitmee* (cotype in Gray Herb.) *Vaupel 59, 449,* in U. S. Nat. Herb. FIJI, *Gillespie 5125.* QUEENSLAND, *Brass 2309.*

In spite of the serrulate margin this is a *Sphaerocionium,* as the term is now applied by Christensen, not a *Leptocionium.* The teeth are even less conspicuous than on *H. Reinwardtii.* The affinity is to *H. javanicum.*

The Fiji specimen which serves me for illustration, the drawings made while it was mistaken for new, is identical with the *Whitmee* cotype. There is another Samoan specimen, *Reinecke 160,* in U. S. Nat. Herb., determined by Christ, Engler's Jahrb. 23 (1896) 337, as *H. fucoides* Sw., described from Jamaica, and except for this collection known from the American Tropics only. Contrary to Christ's judgment, I do not find it quite like the American plant; it is very obscurely serrulate, while *H. fucoides* is conspicuously so. The two do agree in wall structure, the thin internal walls being inconspicuously toothed at the surface. To the naked eye it seems to me to be *H. samoense,* to which I refer it in spite of the walls.

There is no original material of *H. Shirleyanum* in the Queensland Herbarium, but Mr. White sends me *Brass 2309,* so identified by Mr. Everest. The identification is evidently correct, and the plant is perfectly typical *H. samoense.*

79. HYMENOPHYLLUM EMARGINATUM Swartz. Plate 53.

Hymenophyllum emarginatum SWARTZ, Schrad. Journ. 1800^2 (1801) 101 (not seen); Synopsis 148, 377.

Hymenophyllum eximium KUNZE, Bot. Zeit. 4 (1846) 478; VAN DEN BOSCH, Hymen. Javan. 57, *pl. 46.*

Hymenophyllum leptodictyon C. MÜLLER, Bot. Zeit. (1854) 734 (?).

Hymenophyllum inclinatum VAN DEN BOSCH, Plant. Junghuhn. (1856) 570.

Hymenophyllum modestum VAN DEN BOSCH, Ned. Kruid. Arch. 5^3 (1863) 163.

Hymenophyllum demissum auct. plur. partim, non Swartz.

Hymenophyllum dilatatum auct. plur. partim, non Swartz.

H. emarginatum frond. dichotome sub-3-pinnatis oblongis, pinnis decurrentibus, pinnulis bipartitis, lacinulis linearibus emarginatis, terminalibus elongatis, soris supraaxillaribus. Java.—SWARTZ, Synopsis 148.

Habitat in montibus Javae. Thunberg.

Surculi longissimi, teretes, nudi radicantes radiculis filiformibus longis villosis fuscis.

Stipites teretes, glabri, stricti, 2–3 pollicares.

Frondes semispithameae, oblongae, subtripinnatae, glabrae, diaphanae. *Raches* marginatae.

Pinnae decurrentes, alternae, laxae.

Pinnulae dichotomae, seu bipartitae.

Laciniae latiusculae, lineares obtusae apice emarginatae; terminales 2–3-plo-longiores; omnes margine interrimae.

Sori terminales in laciniis brevioribus versus apicem frondis globosi. *Columella* inclusa.

Valvulae indusiorum subrotundae, majusculae, erectae, conniventes.

Observatio.

Species inter majores numeranda, laciniis terminalibus elongatis notabilis.—SWARTZ, Synopsis 377.

A painstaking effort to fix the identity of *H. emarginatum* by means of Swartz's description and of rich Javan material lead to the conclusion that it might be (using usual names) *H. formosum*, *H. eximium*, or *H. Junghuhnii*, and was most probably the first. However, subsequent receipt of a type fragment, from Stockholm, fixed it with absolute certainty as the plant best known as *H. eximium.*

This species was very perfectly described and illustrated from fully fruiting material in Hymenophyllaceae Javanicae, where van den Bosch notes that both *H. eximium* and *H. leptodictyon* were based originally on poor specimens. Of the latter, what may represent the type in the Leyden Herbarium is this species, but another specimen so named seems to me rather to be *H. imbricatum.*

Distinguished from *H. imbricatum* by the rachis, terete or at most narrowly marginate in the lower part, the clavate receptacle, and the usually narrower involucre with erose lip margins. The valves are inconstant in form, most commonly more or less truncate.

Hymenophyllum modestum was described from a single, and evidently not too mature or well-developed specimen, *Cuming 212,* as represented in the Berlin Herbarium. We have good specimens of this collection in the Philippine National Herbarium and the United States National Herbarium. They represent the species common in the Philippine and Malay regions, construed by Presl, Hooker, and many others as *H. demissum* Sw.—which it is not. Van den Bosch emphasized the form of the frond, "basi valde angustata," as a specific character. Our fronds of

the type collection have broad bases, but fronds with reduced lower pinnæ are not rare. The "parietibus . . . marginalibus . . . externe crenulatis" are conspicuous on the type specimen, and not on our cotypes, which at first made me suspect a mixture under the one collection number. But more thorough examination of the cotypes showed a variety of marginal walls—perfectly even and straight, or sinuate-thickened, or crenate or pitted—all on single fronds. Typical *H. modestum* has narrower segments and even more wingless rachis than does typical *H. eximium,* but the two forms intergrade completely in the Philippines.

Common in Java, Sumatra, Borneo, and the Philippines. Philippine specimens are: *Cuming 212* (type of *H. modestum*) ; *Bur. Sci. 5951, 9807, 14768, 19595, 19680, 19712 bis, 27927, 38589, 38926, 40613, 76536; Merrill 6083,* from Mount Halcon; *F. B. 7957; Topping 1232; Williams 2496; Elmer 9910.*

A New Caledonia specimen received by the Herb. Univ. Calif. from Rosenstock as *Franc 1046 part.* seems to be correctly named as *H. eximium,* but is very far from the range otherwise known.

80. HYMENOPHYLLUM JAVANICUM Sprengel. Plate 59.

Hymenophyllum javanicum SPRENGEL, Syst. Veg. 4 (1827) 132; BLUME, Enum. 222; VAN DEN BOSCH, Hymen. Javan. 50, *pl. 40.*

Hymenophyllum crispum NEES and BLUME, Nova Acta 11 (1823) 128, *pl. 14, fig. 1, non* H. B. K.

Hymenophyllum erosum BLUME, Enum. (1828) 221; VAN DEN BOSCH, Hymen. Javan. 54, *pl. 43.*

Hymenophyllum daedaleum BLUME, Enum. (1828) 226.

Hymenophyllum micranthum VAN DEN BOSCH, Pl. Jungh. 1 (1856) 566; Hymen. Javan. 52, *pl. 41.*

Hymenophyllum fimbriatum VAN DEN BOSCH, Hymen. Javan. 55, *pl. 44, quoad plantam javan., nec* J. Sm.

Hymenophyllum australe auct. recent., partim, non Willd.

H. fronde 3-pinnatifida, foliolis 3-angularibus decurrentibus pinnatifidis, laciniis linearibus obtusis undulatis, receptaculis subrotundis, stipite alato. Java. (H. crispum Nees.)—SPRENGEL, loc. cit.

Rhizome wiry, brown, smooth; branched and intricate; stipe 3 to 5 cm long, winged, like the rachis, with a conspicuous, entire, but undulate or crisped, wing; frond commonly 6 to 10 cm long, 3 to 4 cm wide, tripinnatifid, all axes winged like the rachis but less crisped, pinnules and segments at a rather acute angle, contorted and imbricate with the least loss of water, segments about 1 mm wide, 3 to 5 mm long, straight and flat or undulate, entire, walls uniformly thin, straight or minutely wavy, the margin uniform, or with the individual cells convex; sori

abundant, very variable, most commonly 0.7 mm wide, rarely more than 1 mm, involucre cleft to the base, oblong or oval, the apex truncate, rounded or subacute, lip variously irregular—crenate, dentate, incised, or sublacerate; receptacle short and slender, with inconspicuous sporangiophores. A very common little fern of the mossy forest in Java, where the forms that have been called *H. micranthum*, *H. erosum*, and *H. fimbriatum* occur together and intergrade completely.

The range extends to Ceylon, the Peninsula (*Singap. Field Nos. 18605, 20778*), Borneo, Amboyna (*De Vriese*), Papua (*Schlechter 19724, Keysser 176 p.*), New Caledonia (*Vieillard 2286, Balansa 1636 part., Franc 2003*), Fiji (*Gillespie 3823*), and Australia.

Sumatra specimens identified according to the involucre as *H. javanicum*, *H. erosum*, and *H. micranthum* can no more be distinguished thus than can those from Java; but all are alike somewhat different from Java plants in being more divaricate in branching, and therefore more lax, in appearance more like *H. crispatum*.

Of the species that have been confused with *H. javanicum*, only the Philippine *H. fimbriatum* is a very near relative. It has larger sori, with more lacerate lips, and the branches stand at a wider angle. Neither *H. javanicum* nor *H. fimbriatum* has yet been collected in Mindanao or Palawan. *Hymenophyllum australe* has a secondary marginal row of cells; *H. crispatum*, a capitate receptacle; and both differ in other respects.

From both the Malay Peninsula and Australia I have specimens named *H. javanicum* with a perfectly flat axial wing. None are perfect specimens; I do not know what they are.

80a. HYMENOPHYLLUM HUMBOLDTIANUM Fournier.

Hymenophyllum Humboldtianum FOURNIER, in Ann. Sci. Nat. V 18 (1873) 265.

Fronde 3–4" longa, stipite paullo breviori quam limbus, pilis linearibus brevibus hirto, sub apice marginato, limbo lanceolato obtuso, pinnis 6–7-jugis, imbricatis, ovalibus-obtusis, pinnulis cuneato-obovatis, appressis, imbricatis, nervulis 3-chotomis, lacinulis latis obtusis subaequalibus; soris mediocribus, in dimidia superiore frondis parte lacinulas superiores terminantibus, liberis, rhachi flexuosa marginata, indusio ad basim usque fisso, lobis orbicularibus obsolete denticulatis, columella inclusa.

[New Caledonia.] In monte *Humboldt*, 1130 m., octobri sporigerum (Bal. n. 1638).—FOURNIER, loc. cit.

I have not seen this, and merely guess at its proper position in placing it near *H. javanicum*.

80b. HYMENOPHYLLUM PRODUCTOIDES J. W. Moore.

Hymenophyllum productoides J. W. MOORE, Bishop Mus. Bull. 102 (1933) 5.

Rhizoma repens nudum, folia ovato-oblonga glabra valde viridia 10–18 cm. longa 4–6 cm. lata, petiolus 3–4 cm. longus ½ mm. crassus nitidus valde fuscus, praeter ½–1 cm. imum alis crispatis sursum ad 1 mm. latis instructus, rachis similiter alata segmentis crispatis 3 mm. altis in axillis pinnarum instructa, pinnae ad 13 utrinque alternae in lacinias secundarias 1–3 dichotomas pinnatisectae laciniae ultimae oblongo-lineares planae integrae falcatae 2 mm. latae emarginatae, septa cellularum marginalium prominentiis interioribus carentia, sori plures ad laciniarum apices gesti ex lamina liberi, indusium elongato-deltoideum acutiusculum in valvas duas omnino divisum 2½ mm. longum integrum, sporangia plus minusve 445 x 363 μ, sporae circa 46 × 46 μ.

Field number 660, March 5, 1927, altitude 300 meters; on moss-covered branches of trees, ridge, south end of Opoa Mountain. Endemic. (Raiatea)

A close relative of Hymenophyllum productum Kunze, of Java, this Raiatean plant differs in the following respects: tips of the indusium not toothed, tissue filling in the angles made by the primary branches of the frond more abundant, wing of the stipe and rachis crisped, not plane, veins of the ultimate segments with more numerous cells and smaller lumens.—MOORE, loc. cit.

After completion of this manuscript, I received by the courtesy of the director of the Bishop Museum sterile fronds and a fertile fragment of this species. The receptacle is cylindric, with inconspicuous sporangiophores. The closest affinity seems to be to *H. javanicum,* from which it is distinguished by broader segments and entire lips.

81. HYMENOPHYLLUM FIMBRIATUM J. Smith. Plate 60.

Hymenophyllum fimbriatum J. SMITH, Hooker's Journ. Bot. 3 (1841) 418 *nomen;* HOOKER, Sp. Fil. 1 (1844) 102, *pl. 36 C;* VAN DEN BOSCH, Hymen. Javan. 55 *quoad plantam philip.*

Hymenophyllum fraternum HARRINGTON, Journ. Linn. Soc. 16 (1877) 26, *non* Presl.

Hymenophyllum Steeri C. CHRISTENSEN, Index (1905) 361, 368.

Hymenophyllum fimbriatum, J. Sm.; fronds erect ovate subacuminate tripinnatifid, the segments simple or bifid linear obtuse entire undulato-crisped especially at the rachis, involucres copious all terminal campanulate free sessile 2-valved to the base, the valves somewhat plaited truncate fimbriato-dentate, stipes winged almost to the very base, the wings much crisped. (Tab. XXXVI. C.)—*J. Sm. Fil. Philipp. l. c. p.* 418, *name only.*

Hab. Luzon, Cuming, n. 218.—Stipes 2–3 inches; frond 4–5 inches. A good deal resembling *H. Javanicum,* but the fructifications are very different.—HOOKER, loc. cit.

This species is distinguishable from *H. javanicum* in aspect by rather more divaricate branching and less tendency to become

contorted with the least loss of water; in details, by larger sori with more constantly and conspicuously fimbriate lips, and often by an irregularity of the margin, suggestive of *H. Reinwardtii.* It has its range in common with the latter (locally), and is distinguished by broader sori with more dissected lips, noncapitate receptacle, and the absence of marginal teeth visible without a lens; also, in general, it is smaller, relatively (to length) broader, and more crinkled. The distinctions from *H. javanicum* are in degree. If the two were common together they might not be distinguished. The normal sori of *H. fimbriatum* are 1.2 to 1.5 mm wide; of *H. javanicum,* hardly more than half of this. Rarely a sorus up to 1.5 mm wide can be detected on a Javan specimen, but, as noted under that species, I find no significant correlation between size of sorus and dissection of lip. The teeth of the lip of *H. fimbriatum* seem to be quite variable; but, as long, attenuate teeth are deciduous, caution is needed before deciding that they are absent. The internal walls are finely pitted, although only slightly thickened. The different structure shown by van den Bosch, Hymen. Javan. pl. 44, is due to his not having had this species, but *H. javanicum,* as his subject.

Hymenophyllum fraternum Harrington, of which I have a type fragment from the University of Michigan, has very long involucres and exceptionally crisped fronds. It is from the mountains of Panay, where more typical *H. fimbriatum* has since been collected. If further collection reveals a plant that has these peculiarities constantly, its name is *H. Steerei,* but, with one very scanty collection it seems more likely to be merely a variant.

Hymenophyllum fimbriatum is endemic in the northern and central Philippines.

Specimens: *Bur. Sci. 6481, 19596, 19761, 22070, 32405?, 32440, 33337, 40252, 40764, 40766, 42225, 44988, 75698, 75699; Elmer 16186; Loher 14843.*

82. HYMENOPHYLLUM RUIKIUENSE Christ. Plate 61.

Hymenophyllum riu-kiuense CHRIST, in Ann. Cons. Jard. Bot. Geneve 4 (1900) 208; NAKAI, Bot. Mag. Tokyo 40 (1926) 244.
Hymenophyllum liukiuense CHRIST, Bull. Boiss. II 1 (1901) 1021.

Archipel des Riu-Kiu: ile Amanie-Oshema, environs de Naze, mars-avril 1896 (Ferrié n. 187).

Planta affinis *Hymenophyllo australi* Spreng. (*H. javanico* Bl.), sed differt fronde angusta, lanceolata, segmentis multo angustioribus, lineariligulatis 1 mm. latis (habitu *Hymenophylli capillacei* Roxb. ex insula San-

tae-Helenae); ala undulata racheos angustiore; rachi haud elastica; soris terminalibus partem superiorem folii occupantibus numerosis multo minoribus, valvis ovalibus denticulatis.—CHRIST, loc. cit.

Representing this species, I have *Faurie 4640,* which I suppose to be a subsequent collection by the discoverer of the species (the published name is Ferrié), from Yakushima, whence Nakai, Bot. Mag. Tokyo 40 (1926) 244, cites a specimen, collector unknown. It looks like a small *H. crispatum* with very narrow wing, but differs in having a columnar instead of a capitate receptacle, the sporangiophores extending down half of its length, instead of being aggregated at the apex. This makes it key out near *H. javanicum,* but I believe its real affinity to be to *H. crispatum.* It has no resemblance to *H. capillaceum,* the frond of which is more lax than that of any species illustrated in this paper.

Stipe 3 cm long, winged at the top; frond 5 to 8 cm long, lanceolate-ovate, bifinnatifid with the larger pinnules once or twice dichotomous, rachis with a narrow, slightly crisped wing, segments about 0.7 mm wide, the wing unchanged in width down to the rachis; cell walls thin, regularly pore-pitted; sori on somewhat shortened and narrowed lateral (not distal) segments, involucre oblong or ovate, 1 mm wide, cleft to the base, the lips irregularly toothed, receptacles short, stout, with prominent sporangiophores on the upper half.

83. HYMENOPHYLLUM CORRUGATUM Christ.

Hymenophyllum corrugatum CHRIST in Bull. Boiss. II 3 (1903) 508, Bull. Géog. Bot. Mans (1906), 101 (var. *elongatum*); CHRISTENSEN, Med. Göteborgs Bot. Trädgård 1 (1924) 50.

Une des espéces les plus délicates, les plus composées et les plus crispées, ressemblant pour le port beaucoup a *H. crispum* H. B. Kth. de l'Amérique tropicale; elle est particuliere pour le stipe renforcé et raide.

Dense caespitosum, rhizomate filiformi ramosissimo intertexto, stipitibus remotis rigidis erectis flexuosis atropurpureis glabratis supra cum rachi incrassatis angustissime alato-marginatis 2½ ad 5 cm. longis. Lamina 2 ad 3 cm. longa rarius longiore, deltoideo-ovata, tripinnatifida pinnis 8 ad 10 utroque racheos latere patentibus sive deflexis, confertis ovatis, pinnulis confertissimis iterum pinnatis laciniis ultimis numerosis saepe palmatis 2 ad 3 mm. longis vix 1 mm. latis lineari-lanceolatis saepe cuneatis obtusiusculis, omnibus partibus frondosis valde crispato-undulatis, marginibus integris, glabratis, obscure brunneis; urceolis numerosis 1 mm. longis terminalibus valvis rotundato-ovatis saepe suborbicularibus margine integris receptaculo incluso.

C'est une miniature du type *H. australe* Sprengel; tres curieux pour la région subalpine d'un pays extra-tropical. La fronde forme une masse compacte de segments crispés et entrecroisés.

Hab. W. China Chang Yang. Wet rocks 6800'. [*Wilson*] *25.*—CHRIST, Bull. Boiss.

Var. *elongatum* n. var.

A type humili et late ovato differt fronde longius stipitata valde elongata ramosissima, ultra 30 cent. longa. [Wilson] 5271, 5271.[a]

—CHRIST, Bull. Geog. Bot.

My only specimen is *Faber 1079,* identified by Christensen, loc. cit., as the variety *elongatum.* The specimen in U. S. Nat. Herb. received as *H. polyanthos,* has fronds from 3.5 to 13 cm long, showing that the "variety" is the species in full development.

Stipe finely filiform; rachis broadly winged, the wing flat next to the axis, the margins strongly crisped; pinnæ slender, and irregular in length; pinnules and segments crisped and contorted as a whole; structure and fructification as in *H. polyanthos.* The fine and densely crisped minor divisions of the frond seem to make this a more than sufficiently distinct local species.

West China, our specimen from Sze Chuen.

84. HYMENOPHYLLUM FLABELLATUM La Billardière. Plate 62.

Hymenophyllum flabellatum LA BILLARDIÈRE, Nov. Holl. Pl. Sp. 2 (1806) 101, *pl. 250, fig. 1.*

Hymenophyllum nitens R. BROWN, Prod. Fl. N. Holl. (1810) 159; HOOKER and GREVILLE, Ic. Fil., pl. 157.

Hymenophyllum Hookeri BORY, in Bélanger, Voyage, Bot. 2 (1833) 84.

Hymenophyllum frondibus pinnatis, ovatis, acutis, pinnis conformibus, subbipinnatifidis, superioribus decurrentibus, lacinulis obtusis, integris bifidisve; indusiis ovatis.

Filix e surculo repente, tomentoso ut radiculae aut nudo, vix sesquipalmaris. Frons plana, ovata, acuta, sordide purpurascens, membranacea, diaphana, pinnata, pinnis ovatis, acutis, ovatove-lanceolatis, subbipinnatifidis, oppositis aut alternis, superioribus in rachim teretem decurrentibus, lacinulis oblongis, obtusis, integris aut bifidis; stipite filiformi, frondis longitudine, infra subtomentoso. Sori pinnarum lacinulas sparsim terminantes, solitarii aut geminati, ovales; columnula frugifera elliptico-oblonga, inclusa; indusiis ovatis, bivalvibus, integerrimis, lacinularum latitudine; capsulis subimbricatis, sessilibus; semilibus ovatis.

Habitat in capite Van-Dieman.—LA BILLARDIÈRE, loc. cit.

Rhizome wide-creeping, 0.5 mm thick, light brown, clothed with long tawny hairs which are likely to be persistent at the nodes, stipes very slender, deciduously hairy, commonly 4 to 8 cm long; frond rather longer than stipe, lanceolate to ovate, broadest at base, small forms often deltoid, tripinnatifid at base, rachis terete below, winged above; lower pinnæ (or all) broad on both sides at base, usually acuminate, lower pinnules large,

pseudoflabellate; segments linear, 4 to 15 mm long, entire; cell walls under low magnification thick and straight, highly magnified and with accurate focus deeply wavy,[2] marginal walls thin; sori on shorter lateral segments on any part of the frond, as wide as the segments or wider, winged at the base, or halfway up, involucre cleft to the wing, firm in texture, lips semiorbicular, entire; receptacle slender, long, but all sporangia usually included, sporangia sessile or nearly so.

Exceedingly variable. The hairiness seems to be more persistent in New Zealand and Polynesia than in Tasmania and Australia. Great variability in size, dissection, shape, compactness, shape of pinnæ, and width of segments is known in every land from which we have many collections. A *Hooker* collection from New Zealand, *Herb. Lugd.-Bat. 908, 282–428,* has several sori on a frond 17 mm long, stipe included. Such a frond has no terete rachis, the single pinnæ are shallowly pedately incised, and most segments are wider than long. Less extremely reduced deltoid, compact forms, 3 to 5 cm long, represent *H. Hookeri.* At the other extreme, the fronds become exceedingly lax, and up to at least 30 cm long; and the unequal prolongation of the ends of the pinnæ may make the shape quite indefinite.

Range: VICTORIA and NEW SOUTH WALES, apparently common, *Betche, Boorman, Edward, v. Müller, Toepffer.* SOUTHEAST QUEENSLAND, *Shirley, White.* TASMANIA, *La Billardière,* type fragment, *Herb. Lugd.-Bat. sub No. 910.28–92,* complete, *No. 908.282–439, Archer, Gunn, Hooker, Kerschner, Ball, Tenison-Woods, Shirley.* NEW ZEALAND, many collectors. LORD AUCKLAND GROUP. FIJI, *Brackenridge.* SAMOA, *Vaupel.* TAHITI, *Grant 4402.* The Fiji specimen is correctly named, but I mistrust its origin; the Wilkes Expedition collected this species in New Zealand also. In publishing the name *H. Hookeri,* Bory stated that Bélanger found this fern in Java, quite surely a mistake.

85. **HYMENOPHYLLUM RUFESCENS Kirk.**

Hymenophyllum rufescens KIRK, Trans. New Zealand Inst. 11 (1879) 457, *pl. 19A;* HOLLOWAY, Trans. N. Z. Inst. 54 (1923) *pl. 65.*

Rhizome creeping slender; stipes, costa and veins when young sparingly clothed with deciduous curved hairs; stipes, very slender, 1–2 inches long, longer than the frond; frond 1–1½ inches long, deltoid, sometimes cuneate at the base, pinnate, rachis winged above the second pair of pinnae; pin-

[2] For a thorough study of the structure of these walls see Mettenius, Hymenophyllaceae 452, pl. 2, figs. 20–24.

nae twice pinnatifid, unequally rhomboid, the lowest pair divided nearly to the mid-rib; the basal pinnules spreading; capsules, terminal, small, half immersed, divided nearly to the base, hairy when young, margins entire or erose.

Hab: North Island—near the source of the Orua, Ruahine Mountains; 2,000 to 3,000 feet, *H. Field*, Junr.! South Island—Okarito, *A. Hamilton*.

The stipes, rachis, costa, veins and involucres are usually hairy, at least when young; but hairs are rarely produced from the surface of the frond; in *H. aeruginosum* they are developed from both surfaces, and from the margins of the frond as well as from the veins; they are usually straight, and never deciduous as in our plant, my oldest specimens of which have very few hairs. The valves of the capsule are minutely erose in my young specimens from the Ruahine mountains, but this character is not developed in the mature specimens from Okarito.—KIRK, loc. cit.

Represented in Herb. Univ. Calif. by a specimen from Westland Hill Forests, *l. et det. J. Holloway;* in U. S. Nat. Herb. by collections by *Brame,* from Westland, and *Cheeseman,* from Te Aroha Mountain, North Island.

On most of the fronds in hand, only a single basal pair of pinnæ is free (with terete rachis above it). The pubescence is variable in density and persistence, the *Holloway* specimen being most hairy. All hairs, I believe, spring from the axes. They consist of an indefinite number of long cells, reach a length of several millimeters, and, being weak and tangled, are easily broken off. The laminar cells are moderately elongate, and are commonly placed in series, parallel at their bases to the veins and then diverging toward the margin. The walls are thick, with a distinct middle lamella in optical section, sinuate-crenate or somewhat irregularly coarsely pitted where they come to the surface. I find the same variability of lips described by Kirk—round and entire, or somewhat elongate and retuse or obscurely lobed.

This species is clearly related to *H. flabellatum,* as stated by Kirk, but has no affinity to the other species, with stellate hairs, with which he compared it. The hairs on the veins of *H. rufescens* are like those on the rhizome of *H. flagellatum.* It may be regarded as a species cognate with *H. Le Ratii,* like it in form of frond and thickening of walls; but that species is glabrous and has long entire lips.

Endemic in New Zealand.

86. HYMENOPHYLLUM LE RATII Rosenstock. ***Plate 63.***

Hymenophyllum Le Ratii ROSENSTOCK, in Fedde's Repert. 9 (1910) 71.

Hymenophyllum; rhizomate repente, filiformi, ramoso, pilis longis, sericeis, albido-flavescentibus vestito, folia subdistantia ferente; stipitibus

0,5–2 cm vel ultra longis, validiusculis, setiformibus, teretibus, atrobrunneis, pilosis; laminis 2–3 cm longis, 1½–2 cm latis, e basi cordata ovalibus, rubro-fuscis, firmis, subopacis, subpinnato-pinnatifidis; pinnis subcontiguis, basalibus horizontalibus, obovatis, 1 cm fere longis, ¾ cm latis, subflabellato-pinnatifidis, plerumque 3–5-lobis, sequentibus 1–2 jugis erecto-patentibus, ceterum cum basalibus subconformibus et subaequalibus, superioribus furcatis vel simplicibus, erectis; segmentis ad 3 mm longis, 2 mm latis, linearibus sterilibus apice rotundatis, integris vel emarginatis, fertilibus in soros attenuatis; rhachibus strictis, ala versus basin evanescente marginatis, infra pilis mollibus, flaccidis, simplicibus, rarius stellatis, vestitis, cum costis venulisque atrofuscis; soris angustis; apicibus laciniarum immersis; indusio e basi conica producto, ad ¾ fere bilobo, lobis angustatis, acutis, integris; receptaculo incluso.

Nova Caledonia: In monte Panié; I. 1910, *l. Le Rat. no. 13.*

Steht dem *Hymenophyllum imbricatum* Colenso aus Neu Seeland sehr nahe, von dem es durch derbere Textur, rotbraune Färbung, weniger dichte Segmentstellung und schmälere, spitze Indusien verschieden ist.

—ROSENSTOCK, loc. cit.

This species is represented by a cotype in the U. S. Nat. Herb., and in all the herbaria at hand by an ample collection by Franc, January 31, 1911, variously distributed as *Franc 1444 and 1446,* and *Rosenstock, Fil. Nov. Caled., Exsic. 64,* the last incorrectly marked "n. spec." The material is uniform and distinct. It is a well-marked species, of the group of *H. flabellatum* and a near relative of *H. rufescens,* from which it is distinguished by nakedness and by the form of the lips. From all forms of *H. rarum* it is distinguished by the deltoid to ovate fronds, usually less than 3 cm long. The internal cell walls are thick, and sinuate-crenate or crenate-pitted where they come to the surface.

This and *H. japonicum* may be exactly alike in size and form, but they are not at all related.

NEW CALEDONIA, on Mount Panié and the plateau of Dogny, as already cited. NEW ZEALAND, *Tilden, South Pacific Plants 290.*

87. HYMENOPHYLLUM RARUM R. Brown. Plate 64.

Hymenophyllum rarum R. BROWN, Fl. N. Holl. (1810) 159; HOLLOWAY, Trans. N. Z. Inst. 54 (1923) *pl. 56.*

Hymenophyllum semibivalve HOOKER and GREVILLE, Ic. Fil. (1829) *pl. 83.*

Hymenophyllum imbricatum COLENSO, Tasm. Journ. 2 (1844) 187, *non* Blume.

Hymenophyllum Gunnii VAN DEN BOSCH, in Baker, Syn. Fil. (1874) 463.

Frondibus bipinnatifidis lanceolatis glabris raris, laciniis margine integerrimis: inferioribus bifidis, involucris terminalibus solitariis, valvis subrotundis. (D.) v. v.—BROWN, loc. cit.

Rhizome and stipes exceedingly slender, dark to black; stipe commonly 3 to 7 cm long, but shorter in dwarfed plants; normal

fronds 6 to 10 (or up to 17) cm long, 14 to 25 mm wide, but reduced specimens common, bipinnatifid, rachis winged throughout or only marginate at the base, segments few, those of ample fronds 2 mm wide, very delicate in texture, sinuses sharp; cell walls thin and straight, the inner side of the marginal wall provided in some places with irregular, incurrent teeth or folds; sori confined to the upper part of the frond, fertile segments usually dilated, sori narrower than the segments, immersed to or beyond the middle, the immersed part bordered by conspicuous branches of the vein, lips rounded, entire, varying from semiorbicular to much wider than long, receptacle very slender, included, sori few. Herbarium specimens have a peculiar persistent odor, which is not that of *H. sanguinolentum.*

Hymenophyllum imbricatum Colenso is a form with short rachis and crowded pinnæ. *H. Gunnii* is a form with narrow segments, only as wide as the small sori.

NEW SOUTH WALES, *Boorman, and Watts.* TASMANIA, *Gunn.* NEW ZEALAND, *Hooker, Kirk, Mrs. Armstrong, Ranft, Holloway, Setchell, Brame.*

The presence of very similar plants in South Africa (*H. fumarioides*) and Antarctic America indicates that this is a remnant of an Antarctic flora. Elsewhere, its nearest recognized relative is *H. polyanthos,* broadly construed.

88. HYMENOPHYLLUM INVOLUCRATUM Copeland. Plate 65.

Hymenophyllum involucratum COPELAND, Univ. Calif. Publ. Bot. 12 (1931) 375.

Rhizomate late repente radicoso, stipiteque 3–5 cm. alto sursum alato gracilibus, ca. 0.4 mm. crassis, nudis, fuscis; fronde vulgo 10 cm. longa, 4–6 cm. lata, acuminata, basi angustata, flaccida, atroviride, glabra, tripinnatifida, costa fusca ubique anguste alata; segmentis ultimis sterilibus 0.6–0.9 mm. latis, usque ad 6 mm. longis, integris, apice rotundatis, fertilibus apice dilatatis; soris ad partem superiorem frondis restrictis, ibidem interdum segmenta omnia occupantibus, involucro plerumque obconico, immerso, ca. 1.5 mm. longo et lato, labiis saepius breviter et late rotundatis, interdum fere nullis, rarius longius rotundatis, integris, receptaculo incluso.

Rarotonga, Arorangi; Parks No. 22134, June 3, 1929, "considerable abundance on rocks and trees." Type in Herb. Univ. Calif., No. 392254; also No. 22238.—COPELAND, loc. cit.

Specimens are in all of the herbaria in my hands. A relative of *H. rarum,* distinguished by coarser venation than have similarly ample fronds of the latter, narrower segments which are not conspicuously widened below the sorus, and usually shorter

free valves. In fact the involucre, in shortness of lips, suggests *Microtrichomanes*.

Known from Rarotonga only.

89. HYMENOPHYLLUM WALLERI Maiden and Betche. Plate 66.

Hymenophyllum Walleri MAIDEN and BETCHE, Proc. Linn. Soc. New South Wales 35 (1910) 802.

Rhizome filiform, sparingly hairy with somewhat rufous scaly hairs. Stipes slender, very sparingly scaly-hairy or naked when old, not winged or very narrowly so in the uppermost part, about ½ to ¾ inch long. Fronds dark-green, ovate, about 1¼ inches long and 1 inch broad, sometimes narrower in the sterile fronds, cut down to the narrowly winged rachis into 5–7 pinnae on each side. Pinnae spreading, the lower ones sometimes almost horizontally, ovate to ovate-lanceolate in outline and overlapping each other pinnately lobed rather above half-way to the midrib, the lobes shallowly lobed again; ultimate lobes short and broad, rounded and with quite entire margins. Sori not numerous, terminal on the upper lobes of the uppermost pinnae; indusium almost orbicular, about one line long and at least as broad, the valves entire or with slightly uneven margins. Receptacle included.

I have for study a specimen of the type collection from Mr. C. T. White.

Rhizome 0.25 mm thick; stipe 0.3 mm thick, 1 to 2 cm tall, terete, pubescent; frond about 3 cm long, 2 cm wide, bifinnatifid with the lower segments (pinnules) forked, rachis and costæ pubescent beneath, naked and prominent above, rachis usually terete above the lowest pinnæ, elsewhere winged; pinnæ mostly imbricate, elliptic, rounded at apex; pinnules imbricate, separated by shallow incisions, cleft shallowly if at all, ultimate segments short, about 1.5 mm wide, rounded, entire; cell walls thin and straight, without dentate thickening except on the inner side of the marginal walls; sori terminating one or a few apical segments, 2 mm long, with a short, immersed tube subtended by widely divaricate branches of the costa, lips large, elliptic-round, entire; receptacle cylindric, more than half as long as the lips.

Known by the type collection, *R. F. Waller*, Evelyn Scrub, North Queensland, November, 1908; and by a suggested var. *orbiculatum* Watt, also once collected, by Watt, at Ravenshoe, North Queensland. This is smaller and rounder, but hardly distinct.

Nearly related to *H. rarum*, from which it differs in form of frond. *H. rarum* is not reported from Queensland.

90. HYMENOPHYLLUM MNIOIDES Baker. Plate 67.

Hymenophyllum mnioides BAKER, Synopsis Fil. (1873) 57.

St. not more than ½ in. l., very slender; *fr.* 1–2 in. l., ¼ in. br., linear, once pinnatifid; *rhachis* winged throughout; the *segm.* all quite simple, linear, the lower ones slightly imbricated, erecto-patent, 2 lin. l., ½ lin. br., the upper ones pressed close to the rachis and much imbricated; *sori* solitary on three or four of the upper segments, large compared with the size of the plant, divided about halfway down, the base campanulate; *valves* more than half a circle, large, membranaceous.

Hab. New Caledonia, Pic du Mont Mu, *Deplanche.*—A minute moss-like plant, with the habit of *Mnium undulatum* or *serratum*, but dark-brown in colour.—BAKER, loc. cit.

Represented by *Franc s. n.*, collected in 1908, summit of Mount Mou (topotype), and *Franc 1457*, collected in 1912, Saint Louis, altitude 500 m.

Fronds commonly 3 to 4 cm long, 6 mm broad; the lower "pinnæ" of most well-developed fronds, and the most of the pinnæ on some, once forked; simple pinnæ 5 mm long, 1.5 mm broad, apex rounded, base broadly decurrent, and the basiscopic side at and above the base often overfull and rolled upward; structure as in *H. rarum*, walls thin, and marginal wall with incurrent teeth in some places; involucre cuneate at base; receptacle slender, included; odor faint. Our specimens bear very few sori.

Endemic in New Caledonia.

A very near relative of *H. rarum.*

91. HYMENOPHYLLUM MONTANUM Kirk. Plate 68.

Hymenophyllum montanum KIRK, in Trans. New Zealand Inst. 10 (1877) 394, *pl. 21B.*

Rhizome slender, wiry, creeping; fronds few, 2–3 inches long, glabrous, linear oblong or oblong lanceolate, bipinnatifid; stipes about 1 inch long, winged nearly to the base; rachis flexuous, winged, pinnae in from 5–8 pairs, mostly alternate, spreading, about one-third of an inch long, cut nearly to the rachis into 2–4 spreading, linear, forked or bilobate segments. Involucres terminating the segments, small, oval, 2-lipped nearly to the base; lips deeply toothed or jagged; receptacle included.

This interesting addition to our flora was discovered on Mountains at the head of Lake Wakatipu by Mrs. Mason, of Queenstown, to whose kindness I am indebted for specimens. *H. montanum* is distinguished from other New Zealand species by its narrow involucres with deeply toothed or jagged tips; it is of membranous texture and of a dull green hue.

In old specimens the segments are slightly constricted immediately below the base of the involucre.—KIRK, loc. cit.

There is a single specimen, *Kirk 564*, in the United States National Herbarium, topotype, if not a cotype. To Kirk's description, it may be added that the internal walls are thickened and obscurely pitted. The receptacle is like that of *H. rarum*, to which it is more related than to *H. javanicum*, with which Kirk compares it, but from which it differs in having narrow segments and decidedly ragged lips.

New Zealand, apparently very rare.

92. HYMENOPHYLLUM INTRICATUM van den Bosch.

H. intricatum VAN DEN BOSCH, Ned. Kruid. Arch. 5^3 (1863) 168.

Fronde ovata vel ovato-orbiculari bipinnatifida, laciniis primariis e basi erecta mox divergentibus, apice decurvis, late imbricatis e basi latissima cordatis vel rotundatis, secundariis divergentibus imbricatis, lacinulis divaricatis latis leviter undulatis sinu lato interstinctis apice truncatis rotundatisve integris, rhachi valida ala lata undulata marginata, pariter ac venae et venulae, concolori, cellulis firmis subopacis parvis regularibus hexaëdris obtusangulis, parietibus crassis hyalinis, interaneis amorphis parietalibus (spatium oblongum diaphanum relinquentibus) spissis fuscis, globulis passim interspersis minutis fuscis, marginalibus minimis valde abbreviatis extus convexis, soris majusculis in lacinulis vix abbreviatis terminalibus compressis, indusio ad basin rectam vel rotundato-conicam usque bilobo, lobis subquadratis vel producto-rotundatis repandis, frequenter emarginatis, stipite 15 millim. vix excedente late alato, valido flexuoso. Rhizoma validum intricatum ramosum repens glabrum, frons 2½ centim. circiter longa, 2–2½ lata, firma rigidiuscula membranacea subopaca, laciniis lacinulisque imbricatis undulatisque intricata.

H. Ricciaefolium proxime affine a nostro differt: habitu, forma frondis, directione laciniarum primariarum, inprimis vero indusii forma omnino diversa obovato-pyriformi, fundo dilatato-conico, ad ⅓ usque bilobo, lobis truncatulis crenulatis, etc.

Hab. van. Diemensland (ad. fl. St. Patrick), GUNN (H. HOOK.).

—VAN DEN BOSCH, loc. cit.

I have seen no specimen except van den Bosch's retained portion of the type, more complete than the fragments he usually kept. In general appearance it is a small *H. Humbertii*, but the walls are moderately thickened and pitted and the involucres are larger.

93. HYMENOPHYLLUM FUMARIOIDES Willdenow.

Hymenophyllum fumarioides WILLDENOW, Sp. Plant. 5 (1810) 526.

Hymenophyllum capense SCHRADER, Gött. gel. Anz. (1818) 919, not seen.

Hymenophyllum Thunbergii PRESL, Hymen. (1843) 124, *nomen.*

Hymenophyllum natalense VAN DEN BOSCH, Synopsis (1859) 46.

Hymenophyllum Zeyheri VAN DEN BOSCH, Synopsis (1859) 48, *nomen.*

Hymenophyllum tabulare VAN DEN BOSCH, Synopsis (1859) 57, *sine descr.*

Hymenophyllum Limminghei VAN DEN BOSCH, Ned. Kruid. Arch. 5^3 (1863) 151.

H. frondibus pinnatis, pinnis pinnatifidis, laciniis linearibus obtusis bifidis, soris terminalibus, indusiis retusus, rachi alata, stipite marginato. W.

Hymenophyllum fumarioides. Bory in litt.

Erdrauchartiger Hautfarrn. W.

Habitat in sylvis insulae Mauritii, Borboniae. 4 (v. s.)

Caudex repens filiformis crassitie setae equinae. Stipes sesquipollicaris marginato-anceps. Frons bipollicaris pinnata. Pinnae semi-pollicares pinnatifidae. Laciniae lineares obtusae bifidae. Rachis alata. Sori in apicibus laciniarum. Indusia elliptica apice retusa, vel si mavis levissime emarginata. W.—WILLDENOW, loc. cit.

This is a geographical segregate of *H. rarum,* distinguished only by being more constantly reduced in stature. It is similarly variable, but not known to become as long or lax as the most ample form of *H. rarum.* The two are identical in anatomical detail, and in the remarkable odor, still perceptible in a collection by Ecklon in 1827.

Hymenophyllum Thunbergii was a name used by Ecklon in distribution, printed without description by Presl. The same material was recognized as *H. rarum* by Kunze, and renamed *H. tabulare* by van den Bosch, still without other description than a reference to Kunze's illustration. In his unpublished sketches, *Herb. Lugd.-Bat. 910, 28–69,* van den Bosch shows the dentate inner marginal wall characteristic of *H. blumeanum,* which can be detected in places on specimens from the Cape (*l. Wright*) and from New Zealand (*Setchell*). This one of his "species" van den Bosch ascribed to the group of *H. polyanthos,* placing all the others near *H. rarum,* although *H. Limminghei* is also rather ample, and from as far north as the Comores.

Range: The Cape to the Comores and Mauritius; a Ceylon specimen, *Herb. Lugd.-Bat. 908, 282–671,* ex Herb. Hooker as *H. rarum,* can be that species, but as a matter of distribution would better be called *H. fumarioides.*

93a. HYMENOPHYLLUM PARVUM Christensen.

Hymenophyllum parvum CHRISTENSEN, in Perrier Cat. (1932) 18 *nomen* Dansk Bot. Arkiv. 7 (1932) 8, *pl. 2, figs. 1–3.*

Euhymenophyllum H. raro R. Br. et affinibus colore texturaque valde simile, differt: lamina lanceolata vel oblanceolata, versus basin saepe paulo attenuata, simpliciter profunde pinnatifida vel pinnata, 0.5–3 cm. longa, 4–6 mm. lata; pinnis 4–12-jugis, adscendentibus, saepe imbricatis, omnibus simplicibus, apice subemarginatis, basalibus interdum valde reductis,

maximis 3 mm. longis, 1 mm. vel paulo ultra latis; soris in pinnis superioribus apicalibus, 1–6 in quoque fronde fertili, sat magnis, indusii valvis rotundis, integris.

Mt. Tsaratanana, on tree-trunks, ca. 2000 m. alt. Janv. 1923 (PERRIER 15602, type in Herb. Perrier de la Bâthie), forêt orientale sur la Vohitra près d'Ambatovola, Janv. 1928 (idem 18377), Manankazo (idem 7591), sine loco (GREGORY, Kew).

I venture to describe this small fern as a new species; certainly it is closely related to *H. rarum* R. Br. and its South African representatives (*H. fumarioides* Wildd., *H. tabulare* v. d. Bosch), but it differs from all forms of this group known to me by its lanceolate small fronds with invariably simple pinnae; its nearest relative is probably *H. Balfourii* Baker from the Mascarene Islands, but this small fern has deltoid fronds with the lower pinnae forked and a single apical sorus, which is deeply immersed in the lobe.—CHRISTENSEN, Dansk Bot. Arkiv.

The United States National Herbarium contains, from Doctor Christensen, *Perrier 18377*, a tuft of moss containing many minute fronds. Of these, at least four are fertile, bearing one sorus each. On three fronds, one of them only 6 mm long, I find the basal pinnæ forked. A frond of this size is more round than lanceolate, and the forked basal pinnæ may well be responsible for its description as deltoid. The distinctions between *H. parvum* and *H. Balfourii* tend thus to disappear. Moreover, it must be remembered that dwarfs are in general unstable in degree of dwarfing, and, therewith, in form.

The description of *H. Balfourii,* of which I have seen no (other) specimen, follows.

93b. HYMENOPHYLLUM BALFOURII Baker. Plate 69.

Hymenophyllum Balfourii BAKER, Annals Bot. 5 (1891) 192.

Rhizome filiform, wide-creeping. Stipe filiform, very short. Frond deltoid, glabrous, ¼–½ in. long, cut down to a narrow wing into 3–6 erecto-patent lobes, the upper simple, the lower forked. Sorus one to a frond, immersed in the end of a lobe; indusium with a cuneate tube and orbicular lips. Bourbon, *Balfour.* Near the American *H. abruptum,* Hook. —BAKER, loc. cit.

Returning now to the Madagascar plant, *Perrier 18377:* This specimen contains no frond more than 11 mm long. The sorus in every detail, and the microscopic structure, including local incurrent teeth of the marginal wall, are exactly those of *H. fumarioides.* Christensen's description covers fronds up to 3 cm long and with as many as six sori. Such fronds present a degree of dwarfing not at all remarkable in *H. fumarioides.*

My impression is not merely that *H. Balfourii* and *H. parvum* are too much alike, but that both are unfixed dwarf forms of *H. fumarioides.*

Taking this view of *H. parvum,* I can have no other as to *H. compactum* Bonaparte, which I have not seen. By description, it is intermediate between *H. fumarioides* and *H. parvum.*

94. HYMENOPHYLLUM VERONICOIDES Christensen.

Hymenophyllum veronicoides CHRISTENSEN, in Bonaparte, Notes, Pterid. 12 (1920) 20.

Hymenophyllum remotipinus BONAPARTE, Notes Pterid. 16 (1925) 17.

Parva, stipite setiformi, tereti, glabro, atrofusco, 2 cm longo. Lamina lanceolata, 4 cm longa, vix 1 cm basi lata, glabra, fusca, tripinnatifida. Rachi sursum anguste alata. Pinnis 15-jugis, deltoideis, 4–5 mm longis, costa alata; pinnulis inferioribus subpinnatifidis, superioribus furcatis; segmentis ultimis obtusis vel leviter emarginatis, sub 1 mm longis, plus minusve convolutis. Soris ad tertiam partem superiorem frondis aggregatis, 3–4 pro pinna; indusiis duplo vel triplo quam segmento fructifero latioribus, valvis rotundis.

This new species seems to be very distinct. The whole leaf resembles strikingly a fruiting plant of some small annual species of *Veronica,* because the large somewhat inflated indusia are crowded at the upper third of the leaf as are the capsules of *Veronica.* The narrow leafy parts of the segments are rolled over the thick medial vein. The dried plant is of the same characteristic brown colour as *H. fumarioides.*

Madagascar: Région floristique du Centre. Massif de Manongarivo, vers 1400 mètres d'altitude. Bois secs. Au pied des troncs dans les endroits obscures. *H. Perrier de la Bâthie,* n. 7775.

Another specimen, no. 7774, from quite the same locality is no doubt belonging here; it is in size, colour and crowded sori like the type, but the lamina is narrowed downwards and the leafy parts of the segments as well the wing to the rachis are broader and all rolled over the vascular parts.—CHRISTENSEN, loc. cit.

The United States National Herbarium contains a frond, from Doctor Christensen, of a subsequent collection, *Perrier de la Bâthie 15607,* from Mount Tsaratanana, altitude 2,400 m. It is perfectly typical, 4 cm long, 11 mm wide just above the base. To appreciate the fineness of dissection one must associate these dimensions with the presence of seventeen pairs of pinnæ, the larger of these with seven pairs of pinnules, which in turn may have three or four segments. The broader expanded segments are 0.4 mm wide, but the tendency is to remain rolled in, even when wet. All axes are exceedingly slender. The involucres are up to 1 mm wide, subtended by widely divergent "arms" of the vein, and, as far as seen, perfectly entire. Receptacle filiform, included.

The dried plant has, faintly, the odor as well as the color of *H. fumarioides.* The structure is exactly that of *H. rarum,* even

to the occasional presence of rounded teeth incurrent from the marginal wall.

95. HYMENOPHYLLUM HUMBERTII Christensen.

Hymenophyllum Humbertii CHRISTENSEN, Archives de Bot. 2 (1928) 209, Dansk Bot. Arkiv. 7 (1932) 10, *pl. 2, figs. 6–8.*

Hymenophyllum deltoideum CHRISTENSEN, Dansk Bot. Arkiv. 7 (1932) 10, *pl. 2, figs. 4, 5.*

Rhizomate repente filiforme, subnudo. Stipitibus 1,5 cm. longis, juvenilibus fere ad basin anguste alatis, vetustis exalatis, teretibus, rigidis, cum rachi pilis rufis deciduis superne onustis. Lamina deltoidea vel ovato-deltoidea, 2,5–3 cm. longa, 1,5–2 cm. lata apice rotundata, obscure viridi, tri-quadripinnatifida. Pinnis 3–4-jugis, ovatis, obtusis, segmentis ultimis linearibus vix 1 mm. latis valde crispis; rachibus costisque crispo-alatis. Soris apices segmentorum summorum solum occupantibus, majusculis, quam laciniis soriferis latioribus, indusiis ovatis, ultra medium bilobis, valvis ovatis, obtusis, integris.

Haute vallée de la Rienana, bassin du Matitanana (Humbert 3351, Typus in Herb. C. Christensen).

Cette nouvelle espèce, par sa petite taille et ses frondes crispées, ressemble à *H. Pollenianum* Rosenstock qui ne m'est connu que par sa description; la fronde ovale-deltoide avec les pennes basales souvent plus grandes ainsi que les stipes et rachis poilus des jeunes feuilles l'en différencie suffisamment.—CHRISTENSEN (1928).

Hymenophyllum deltoideum should be distinguished "by its plane cordate glabrous frond with broader, more divaricating segments." The figures in Dansk Bot. Arkiv. look distinct enough. But Dr. Christensen has provided the U. S. Nat. Herb. with fronds of the type and other known collections of both, and I am unable to regard them otherwise than as one species. Both have broad, deeply cordate fronds. Hairs are deciduous, almost completely on *H. Humbertii,* and *H. deltoideum* is not quite glabrous. The fronds of *H. deltoideum* are slightly crisped; distinctly less so than those of *H. Humbertii,* but the difference is not greater than is common in *H. javanicum.* And the lips of the valves of these fronds of *H. Humbertii* are not entire. *Hymenophyllum Humbertii* was collected at an altitude above 1,000 m, *H. deltoideum* at 300 m; difference in exposure may explain such differences in frond as exist. *Hymenophyllum deltoideum* has broader, more spreading segments, but the difference is within the range of variation of many species, and rounded sinuses are alike on both.

The structure is that of *H. rarum,* and the odor, though faint, is present. Some of the receptacles of *H. deltoideum* protrude

slightly, as the unpublished drawing of van den Bosch shows those of *H. fumarioides*. In spite of the very different shape of frond, they belong in this group.[3]

95a. HYMENOPHYLLUM DELTOIDEUM C. Chr.

Hymenophyllum deltoideum C. CHR. in Pierre Cat. 18, *pl. 2, figs. 4 and 5;* in Dansk Bot. Arkiv. 7 (1932) 10.

Rhizomate filiformi pilis sparsis vestito, cito nudo, late repente; stipite 1.5–2.5 cm. longo, fere ad basin cuneatim alato, subtus pilis rufis sat dense hirto; lamina late cordato-deltoidea, 4–5 cm. longa, basi 3–4 cm. lata, olivacea, glaberrima, triquadripinnatifida, rachi ubique alata; pinnis 5–6-jugis, basalaibus maximis, usque ad 2 cm. longis, deltoideis aequilateralibus anadromice divisis (lamina ita plerumque basi cordata), rarius fertilibus superioribus subdimidiatis, supremis plerumque magis abbreviatis, soriferis, partitionibus omnibus 1 mm. vel paulo ultra latis, planis, marginibus leviter undulatis, lobis ultimis 4–6 mm. longis, obtusis. Soris in lobis superioribus apicalibus, numerosis, basi paulo immersis, quam lobis latioribus, indusiis ultra medium divisis, valvis ovatis, extus rotundatis vel subacutis, levissime crenulatis vel integris, receptaculo parum exsertis.

Bassin du Mangoro, épiphyte vers 300 m. alt. Oct. 1927 (PERRIER 18151, type in Herb. C. Chr.).

This new species is best characterized by its short, broadly deltoid and usually cordate fronds; it comes near to *H. tenellum* (Jacq.) Mett., differing by its subentire valves of the indusium and by the shape of the frond; from *H. Humbertii* C. Chr. it differs by its plane cordate glabrous frond with broader, more divaricating segments.—C. CHRISTENSEN, op. cit., 10.

96. HYMENOPHYLLUM IMBRICATUM Blume. Plates 70 and 71.

Hymenophyllum imbricatum BLUME, Enum. (1828) 220.

Hymenophyllum formosum BRACKENRIDGE, U. S. Explor. Exped. 16 (1854) 268, *pl. 32, fig. 3;* VAN DEN BOSCH, Hymen. Javan. 59, *pl. 47, 48.*

Hymenophyllum dilatatum auct. mult. partim, non Swartz.

Hymenophyllum sororium VAN DEN BOSCH, Synopsis 55, excl. syn. Presl.

Hymenophyllum bamlerianum ROSENSTOCK, Fedde's Repert. 10 (1912) 323.

H. fronde bipinnatifida ovata purpurascente glabra, pinis alternis approximatis rhombeo-oblongis pinnatifidis, laciniis (s. pinnulis) trapezoideis sursum incisis subimbricatis, lacinulis linearibus obtusis, indusii valvis orbiculatis integerrimis, stipite tereti.

[3] After submission of this manuscript I receive from Doctor Christensen additional material representing these species. To the naked eye, they seem distinct indeed. The more minute resemblances are so complete that I am still inclined to construe the differences as edaphic; but I insert the description of *H. deltoideum* for the sake of completeness.

Obs. Ab. *Hymenophyllo sanguinolento*, Sw. differt pinnulis subdimidiatis, sursum modo subpinnatifidis et subimbricatis.

Crescet in Javae montibus locis muscosis.—BLUME, loc. cit.

With recognition of the fact that *H. dilatatum* is endemic in New Zealand, a great number of Malayan and Polynesian collections that have borne this name must be named anew; and the considerable number of published "species" which have in modern use been reduced to *H. dilatatum* present possible substitute names. Among these species, *H. emarginatum* has a wide margin of priority; but examination of type material has shown that it is the species commonly called *H. eximium.*

The next name in point of time is *H. imbricatum* Blume, which has also escaped recognition by the later writers. The Blume specimen in Leyden Herb., a unique, is a small frond, with a single sorus which I do not venture to investigate. It is matched by *267 Horti Bogor., Herb. Lugd.-Bat. 908, 282–193,* identified in the herbarium by Rosenstock as *H. imbricatum.* The Blume specimen has a rather broad wing, this one a narrow one, but both seem to me unquestionably to be small specimens of otherwise typical *H. formosum.* Its receptacle is shown by Plate 70, figs. 5 to 8.

Hymenophyllum formosum is supposed to have a very characteristic receptacle, described as "breve apice capitato," and figured by both Brackenridge and van den Bosch as having a slender sterile base, and a relatively very large spherical head, on which the sporangia are borne on mere traces of pedicels. I have not seen another Tahiti collection which matches these figures closely. Some Philippine specimens do. Most Javan specimens have conspicuous pedicels, inferior in length and size only to those of well developed *H. Junghuhnii.* To test the status of the receptacle, as specifically characteristic in this species, we have examined very many collections and hundreds of sori. The observation as to the pedicels has just been stated. As to form, it varies from globose or moderately depressed and dilated, to broadly or narrowly balloon-shaped or pyriform. Beyond the extreme in one direction is the malleiform receptacle of *H. Junghuhnii,* and in the other the clavate one of *H. eximium.* As a rule, the receptacle is quite uniform in mature sori of any one plant—for an exception, see Plate 70, figs. 5 to 8, from the specimen representing *H. imbricatum.*

Finally I have felt justified in subjecting the type of *H. formosum* to careful study. It consists of two sheets in the United States National Herbarium. One is juvenile. The other, really the type, *No. 57587*, consists of two large fronds attached to a rhizome, and one detached large frond. The former has receptacles with depressed-globose, nearly smooth heads, such as have been figured for the species. The latter has a head which would pass for that of *H. Junghuhnii*—wide, and with very conspicuous sporangiophore branches. It has occurred that specimens of the Wilkes Expedition from different lands were mounted on one sheet; but in this instance the three fronds are so perfectly alike in all other respects that I feel sure they represent one collection; and that *H. formosum* as represented by the type itself bears receptacles of the whole range of forms, except narrower than spherical, of *H. imbricatum*.

Hymenophyllum bamlerianum was based on *Bamler S. 50* and distributed as *Fil. Novoguin. exsic. 207*, which is in Gray Herb. and Herb. Univ. Calif. The former conforms to the description, with fronds less than 7 cm wide, and the stipe with a crisped wing running almost to the base. The Herb. Univ. Calif. specimen has a frond nearly 10 cm wide, and the stipe is wingless practically to the top—as near to typical *H. formosum* as it is to *H. bamlerianum* as described. *Bamler 50*, from the same place, in Herb. Univ. Calif., is still more nearly *H. imbricatum*, well identified by Doctor Rosenstock as "*H. formosum, forma*." The sorus is that of *H. imbricatum*, not, as described, that of *H. Junghuhnii*. We have illustrated the sorus, including receptacle, of *Bamler 50* and *Bamler S. 50* (at any rate, *Fil. nov.-guin. exsic. 207*), and find the range in receptacles exactly the same as in the type of *H. formosum*. It seems to me that *H. bamlerianum* is an unstable or unfixed local variant of *H. imbricatum*, and that Bamler, with the judgment of a good collector, recognized the various forms as those of one species. The most distinctive feature of the local form is the moderate crisping of the wing, suggesting, as Rosenstock noted (*H. macrocarpum* Presl), *H. badium*.

As usually happens with a species of so wide a range, there are recognizable local forms. Thus, Samoan specimens have practically sessile sori (obsolete fertile segments); while those from the southern Philippines have them on narrow, pedicel-like segments, and the fronds are remarkably large—"formosum," indeed. The material from Java and Tahiti is remarkably alike in appearance.

Range: JAVA, very many collections, mostly named *H. formosum;* among them, *Herb. Lugd.-Bat. No. 908, 281–186,* determined by van den Bosch as *H. leptodictyon* C. Müll., which, according to his text, Hymen. Javan. 58, 59, should be *H. eximium.* PHILIPPINES (Negros, Mindanao), *Merrill 952, Elmer 10205, 11517, Bur. Sci. 14767, DeVore and Hoover 340, Copeland 1012, 1142.* CELEBES, a specimen ex Herb. Waitz, *Herb. Lugd.-Bat. 908, 282–147,* from Mount Klabat, *Koorders 170178.* NEW GUINEA, *Werner 49, Bamler 28, 50.* NEW HEBRIDES, *Kajewski 602, 868.* FIJI, *Seemann 785, Horne 27, Parks 20614, Gillespie 3823.5.* SAMOA, very common. TAHITI, *Brackenridge,* (type of *H. formosum*) *Grant 5326.*

97. HYMENOPHYLLUM TREUBII Raciborski. Plate 72.

Hymenophyllum Treubii RACIBORSKI, Pterid. Buitenzorg (1898) 15, Nat. Tijds. Ned. Ind. 59; *pl. 3.*

Rhizom fadenförmig, kriechend, bis 0.2 m.m. dick nur sehr spärlich mit Haaren besetzt. Blattstiele fadenförmig, bis 0.2 m.m. dick, 2–3 c.m. lang, kahl, unterhalb der Lamina sehr schmal geflügelt. Lamina doppelt gefiedert, durchsichtig, hell grün, im Umriss oval, bis 4 c.m. breit, bis 8 c.m. lang. Rachis jederseits bis 1 m.m. breit geflügelt, gewöhnlich nicht grade aber wellenförmig verlaufend. Die primären Segmente mit ebenso verlaufender Rachis, oberseits mit 1–3 Lacinien, unterseits ohne dieselben, oder mit einen, ausnahmsweise mit zwei Segmenten. Die basalen Segmente gewöhnlich gegabelt, die letzten Enden bis 1 c.m. lang. Alle Lacinien, ebenso wie die Rachis der Segmente 2 m.m. breit, am Rande kahl, ohne Randnerven. Sori rundlich, bis 2 m.m. lang und breit, mit schmaler Basis einzeln an der Spitze der Lacinien sitzend, von swei rundlichen, bis zur schmalen, graden Basis freien Indusialklappen umgeben. Diese ganzrandig, oder an der Spitze unregelmässig gekerbt.

Ein Epiphyt der bemoosten Baumstämme. In der unteren Waldzone am Süd- und Ostabhang des Salak nicht selten.

—RACIBORSKI, Pterid. Buitenzorg.

Collections by Raciborski from the south slope of Mount Salak, presumably of the type collection, are in Phil. Nat. Herb., Herb. Lugd.-Bat., and Herb. Copeland; *Bakh van den Brink 5879,* in Herb. Lugd.-Bat. and Herb. Univ. Calif., is from the same place and typical. *Hymenophyllum Treubii* var. *novoguineense* Ros., Fedde's Repert. 12 (1913) 525, *Keysser 239 p.,* in Herb. Univ. Calif. from Rosenstock, is too typical to need any additional name. Brause, Bot. Jahrb. 56 (1920) 40, reports four Papuan collections by Ledermann, two each of the typical form and the variety. A specimen from Perak, *M. Haniff 2486,* distributed as *H. dilatatum,* is probably *H. Treubii;* the same is true of *Holttum, Singapore f. n. 21596,* as *H. productum.*

To Raciborski's description I have only to add that the walls are thin and uniform, and that the receptacle is broadly clavate, without evident sporangiophores. On all specimens the wing is evident throughout the rachis and part-way down the stipe. The valves are as stated, either entire or somewhat irregular at the apex.

This species may be a reduced form of either *H. emarginatum* or *H. imbricatum.* The width of segments and wing suggests the former; in the sorus, it is more like the latter. The great distance between the Salak (western Java) and the Sattelberg (eastern Papua) suggests an independent origin in the two places, but there is no other evidence to this effect; *H. emarginatum* is known in both places.

98. HYMENOPHYLLUM JUNGHUHNII van den Bosch. Plate 73.

Hymenophyllum Junghuhnii VAN DEN BOSCH, Plant. Jungh. 1 (1856) 570, Hymen. Javan. (1861) 60, *pl. 49.*

Fronde late oblonga vel ovata angustata tripinnatifida, laciniis divergentibus horizontalibusque, apice saepe caudato-productis, e cellulis mediocribus magnisve regularibus fuscidulis contexta, soris terminalibus praemagnis ex orbiculato transversim latioribus subexsertis ima basi marginatis bilobis, lobis integris sorum ¾ longitudine aequantibus, receptaculo brevi malleiformi, rhachi stipiteque, fronde parum breviore simmo apice, anguste alatis.

Hab. ad truncos arborum in montosis Javae; REINWARDT, BLUME, JUNGHUHN; in m. Tjapoes, Salak et Gedé ZOLLINGER Coll. I N. 1841 a.

Rhizoma validum, filum ferreum crassum, horizontale ramosum glabrum; stipes validus, rhizomate fere crassior, 10–12 centim. longus teres strictus, summo apice anguste alatus; frons usque 1½ decim. longa, 9 centim. lata membranacea firma subopaca olivacea late oblonga vel ovata apice plus minusve angustata elongata tripinnatifida, laciniis primariis inferioribus horizontalibus, superioribus sensim minus divergentibus contiguis leviterve imbricatis e basi obliqua lata ovatis oblongisve acuminatis (nonnumquam apice producto caudatis) bipinnatifidis, secundariis divergentibus vel patulis contiguis rhomboideis vel obcuneatis, exceptis summis 1–2 furcatis simplicibusque, pinnatifidis, tertiariis erecto-strictis, lacinulis late linearibus parum elongatis integris, in sinubus leviter undulatis, apice rotundato-integris; rhachis anguste marginata, alâ integra hic illic leviter undulata venaeque et venulae validae; sinus angusti fundo rotundato-obtuso; sori in laciniis secundariis laterales in lacinula abbreviata subexserti maximi ex orbiculato transverse latiores turgidi, indusio basi recta breviter alata bilobo, lobis integris leviterve repandulis indusium ¾ longitudine aequantibus, receptaculo brevi apice in capitulum malleiforme incrassato; cellulae parum diaphanae, centro nebulosae mediocres, imo magnae regulares hexaëdres subacutangulae, parietibus rectis hyalinis incrassatis, interaneis amorphis diffusis fuscidulis; marginales universe minores.

Tab. XLIX fig. 1 et 2 planta, nat. magn., 3 lacinulae fertiles, 4 steriles, 5 et 6 indusium, 7 et 8 cellulae e margine, 9 et 10 e limbo frondis, 11 et 12 lacinula transversim secta; cuncta magn. auct.

Obs. Hujus loci foret illustratio *H. imbricati* BL. (*Enum.* II p. 220). Etiamsi, visis speciminibus authenticis Herb. Reg. L. B., illud nunc novi, de specie conservanda valde adhuc dubito. Propterea, meliora forsan postea edocturus, nunc memorasse sufficiat.—VAN DEN BOSCH, Hymen. Javan.

Well characterized in Java by its very large and especially wide involucres and malleiform receptacles, with the sporangia on prominent pedicels. The species is common in western Java, apparently not rare in Sumatra, and reported from Dutch Borneo. Such specimens as I have seen so named from Amboyna and Papua are not this species. *Hymenophyllum longifolium,* described from Celebes, is a near relative, but better kept specifically distinct.

It is only in the Philippines, where *H. badium* and *H. emarginatum* are present and variable, that *H. Junghuhnii* has been confused with any other species. There are several collections from Negros and Mindanao which have not been questioned in the past as *H. Junghuhnii,* but it seems better now to regard them as *H. emarginatum.*

There is also one collection from eastern Java, *l. Mousset,* but with Winkler's label, *Herb. Lugd.-Bat. 910.122–1480,* which is more like *H. longifolium.* Both rhizome and stipe are filiform, and the largest frond is 50 cm long and hardly 7 cm wide.

In consideration of its name the type of this species should be a *Junghuhn* collection. I have accordingly illustrated it by the best of these in Leyden Herb. *908.282–194,* which may be regarded as the type. We have examined very many receptacles, and reproduce enough to show how uniform they are.

99. HYMENOPHYLLUM LONGIFOLIUM v. A. van Rosenburgh. Plate 74.

Hymenophyllum longifolium v. A. VAN ROSENBURGH, Bull. Jard. Bot. Buitenzorg II No. 16 (1914) 17; COPELAND, Journ. Arnold Arboretum **10** (1929) 175.

Hymenophyllum Junghuhnii KJELLBERG and CHRISTENSEN, Bot. Jahrb. **66** (1933) 40, *non* van den Bosch.

Euhymenophyllum.—Rhizoma repens, gracile, sparse longi-pilosi. Stipites sparsi, ca 3–4 cm longi, glabri, minime in parte superiore alati. Frondes late lineares, tenues, glabrae, ca 40–50 cm longae, 8–9 cm latae, basi angustatae, rachide late alata. Pinnae copiosae, confertae, patentes, arcuato ascendentes, maximae triangulari-lanceolatae, usque ad 5 cm longae et basi oblique truncato-cuneata usque ad 2½ cm latae, rachide late alata. Segmenta secundaria infra segmentum terminale paullo elongatum usque ad 7 utrinque; segmenta superiora simplicia vel furcata; segmentum infimum anticum maximum, triangulari-oblongum, usque ad 1½

cm longum et 1 cm latum, basi postica 1–2-pinnatifidum, antica 2–4-pinnatifidum. Segmenta ultima ca 1¾–2 mm lata, sterilia obtusa, apice emarginata, fertilia prope apicem constricta; venae in segmentis ultimis solitariae, apicem segmentorum sterilium non attingentes. Sori ad segmenta ultima terminales; indusium 2-valve, valvis rotundatis vel suboblongis, integerrimis vel sub-integerrimis; receptaculum breve, inclusum.

Celebes (*Mt. Boesoe*, Capt. van Vuuren's Exploration Excursion, Rachmat No. 615).—V. A. VAN ROSENBURGH, loc. cit.

This species was described from Celebes, the description applying satisfactorily to our specimens with the help of its author's English version showing that the stipe is winged *at least* in the upper part; this wing may be a full millimeter wide on each side. It is nearly related to *H. Junghuhnii*, the head of the receptacle widened to fully twice its length. It differs from that species in its very elongate fronds, broader wings on the rachises and costae, and shorter segments, which may be emarginate as described, or rounded. It may be suspected that the *H. dilatatum* reported in New Guinea by Brause (in Bot. Jahrb. LVI. 40 (1920) with very long and narrow fronds, is really this species.—COPELAND, loc. cit.

Rosenstock would reduce this to a variety of *H. Junghuhnii*, but the distinctions noted in the preceding quotation may suffice to justify its specific recognition. While the wing of the rachis of the two collections known is essentially plane, there is a slight overfullness of the lamina of the segments, alike in the two collections, which gives the frond the attractive appearance of a "watered" fabric.

Range: Celebes; Papua; and, I believe East Java, Tengger Mountains, *l. Mousset*, and distributed by Rosenstock, *Fil. Javae Or. n. 90*, and by Winkler.

As the cotype in the Leyden Herbarium is defective, I have illustrated the plant by my own specimen of the Papuan collection, *Brass 1467*, U-uma River headwaters, altitude 1,500 to 2,000 m.

100. HYMENOPHYLLUM SALAKENSE Raciborski. Plate 75.

Hymenophyllum salakense RACIBORSKI, Pterid. Buitenzorg (1898) 18.

Rhizom kriechend, fadenförmig, bis 0.8 m.m. dick, spärlich behaart. Blattstiele 4–8 c.m. lang, 1 m.m. dick, von der Basis der Lamina bis zur Anheftungsstelle am Rhizom, oder bis zu einer Entfernung von 1 c.m. vor demselben deutlich geflügelt, die Flügel 1–2 m.m. breit. Lamina dreieckig, von der breiten Basis gegen die Spitze verschmälert, 1–15 c.m. lang, 6–11 c.m. breit, durchscheinend, mit abstehenden, nur wenig nach oben gerichteten Segmenten, doppelt gefiedert mit gelappten Segmenten zweiter Ordnung. Rhachis breit geflügelt, bis 3 m.m. breit, manchmal etwas kraus, Die Lacinien linear, 2 m.m. breit, kahl und ganzrandig. Sori an der Spitze der nicht unterhalb ihrer Anheftung verschmälerten Lacinien, Indusialklappen rundlich, oder ein wenig abgeflacht, 2–3 m.m. breit und lang, ganzrandig, mit flacher nicht nierenförmiger Basis sitzend.

Mit H. Junghuhnii nächst verwandt, doch scharf verschieden, und durch Uebergänge nicht verbunden, von dem mir unbekannten H. Reinwardtii durch ganzrandige Lacinien verschieden.

Auf den bemoosten Baumstämmen am Süd- und West Abhang des Salak, in der mittleren Gebirgszone.—RACIBORSKI, loc. cit.

Raciborski collections, presumably cotypes, are in Leyden Herb. (fertile) and Phil. Nat. Herb. (sterile) ; topotypes, *Bakh v. d. Brink No. 2617,* are in Leyden Herb. and Herb. Univ. Calif. The former contains also an old Herb. Waitz specimen from Mount Gadang. From Sumatra, approximately typical, are *Ajoeb 512* in Leyden Herb., and *Yates 5630* in Herb. Univ. Calif. Christensen, Mitt. Inst. Bot. Hamburg 7 (1928) 142, reports it from West Borneo. A New Guinea specimen in Leyden Herb. received under this name is very distinct (*H. opacum*).

The plant is smaller than *H. Junghuhnii,* with broader wings and segments, and the sori on distal segments which are not contracted, so that they fall in the outline of the frond, while *H. Junghuhnii* has the terminal segments of pinnæ, and commonly of the pinnules as well, sterile and prolonged beyond the most of the sori, *H. salakense* has more the appearance of *H. badium.* Still, I consider it a reduced, local derivative of *H. Junghuhnii,* and, in spite of Raciborski's statement, would expect to find intermediate forms; in fact, loose fronds with *Herb. Lugd.-Bat. 924, 325–207, l. Bakh van den Brink No. 2609,* from the type locality, seem to be intermediate.

101. HYMENOPHYLLUM BADIUM Hooker and Greville. Plate 76.

Hymenophyllum badium HOOKER and GREVILLE, Ic. Fil. (1828) pl. 76; Sp. Fil. 1: 102, 150; Syn. Fil. 60.
Sphaerocionium badium PRESL, Hymen. (1843) 127.
Hymenophyllum Cumingii VAN DEN BOSCH, Synopsis (1859) 55.
Sphaerocionium macrocarpum, PRESL, Hymen. (1843) 127, 153.
Hymenophyllum macrocarpum VAN DEN BOSCH, Synopsis (1859) 55.
Hymenophyllum latilobum BONAPARTE, Notes Pterid. 13 (1921) 103, teste Tardieu and Christensen, Bull. du Mus. 6 (1934) 287.

Fronde lanceolata bipinnatifida, laciniis lineari-oblongis obtusis integerrimis glabris, inferioribus bifidis, soris raris in lacinia inferiori, involucris rotundatis.

Hab. In India Orientali. *Wallich.*

Caudex repens, filiformis, gracilis, ramosus, intricatus, fibroso-radiculosus.

Stipes etiam filiformis, bi-triuncialis, superne alatus.

Frons, circumscriptione, ovato-lanceolata, 4–5 pollicaris, bipinnatifida, segmentis primariis ovato-lanceolatis, laciniis lineari-oblongis, obtusis vel emarginatis, non raro inferioribus bifidis. *Textura* frondis ex areolis parvis. *Color,* siccitate, fuscobadius. *Costa* fusca.

Involucra rara, praecipue versus apicem frondium, in lacinia inferiore ad superiorem partem segmentorum, solitaria, terminalia, rotundata, bivalvia, valvis concavis, integerrimis.

Sori inclusi.

Capsulae paucae, breviter pedicellatae, sphaerico-compressae, columellam brevem terminantes, annulo integro, obliquo.

Semina angulata, et ut. videtur, ternatim congesta.

—HOOKER and GREVILLE, loc. cit.

This species is hard to typify because it was described from a Wallich specimen without stated origin—"probably from Nepal;" and a different species appeared later in Wallich's list under this name—see Sp. Fil. 102. The Leyden Herbarium contains two defective fronds from "Ind. Or." "Herb. Hooker," which are very probably Wallich collections. In the Synopsis, the specimen cited with positive location is by Sir. W. Norris, from the Malay Peninsula. Beddome cited it (as a variety of *H. javanicum*) from Sikkim, Tenasserim, and the Peninsula. Van den Bosch knew it in 1859 (Synopsis 55), by publication only, and regarded it as distinguished from his *H. Cumingii* by "fronde e basi obtuso elliptica, laciniis primariis previbus, soris in hisce axillaribus solitariis, indusii lobis integerrimis, colore badio, etc." He must have received the specimens already referred to at a later date. These specimens are sparsely fruiting, and therefore unlike well-developed ones in shape and position of sori. I suppose that they came from as far south as Tenasserim, rather than from Nepal.

The Norris collection is represented in the Gray Herbarium and the Leyden Herbarium, and I see no reason to doubt its identity. The type collection of *H. Cumingii, Cuming 112,* is represented in the Gray Herbarium, the United States National Herbarium, the Philippine National Herbarium, and my own herbarium, by quite uniform material, which I consider identical with the *Norris* specimen already referred to. As to *Cuming 112* and *130,* the type collection of *Sphaerocionium macrocarpum,* the specimens I have in hand certainly represent one species. Christensen and Ching have identified as this species several Chinese collections of the short form.

Stipe commonly about 5 cm long, rarely exceeding 10 cm, winged in the upper half or throughout, the wing usually broad, sometimes even 2 mm, plane, or sometimes overfull and therefore more or less crisped: frond 6 to 10 cm broad at the base, 10 to 25 cm long, varying from ovate-lanceolate to ovate (common, short form), and to lanceolate (in both the *Norris* specimen and

Cuming 112), obtuse, tripinnatifid, everywhere rather broadly winged and the segments therefore oblong rather than linear, the wing on the rachis sometimes somewhat crisped, apices rounded or slightly emarginate, distal segments never very elongate; cell walls (except marginal) very thick, straight.

The receptacle is interesting and characteristic in its variability. The receptacle is the end of an axis, originally with a growing point like other axes. Elsewhere on the plant, growing points divide, giving rise to dichotomous, eventually monopodial, systems. In most species, any forking of the fertile axis ends (receptacles) is unknown, and in no other is it common. In this species it is common, but varies in the stage at which it occurs. If it is very late in development, the branches do not separate, and the resulting form is that characteristic of *H. junghuhnii,* rare in this species. If it occurs a little earlier, it results in two divaricate or horizontal branches on a common sterile base. There are all stages between simple, broadly club-shaped receptacles—that is, no forking—and those in which the dichotomy is below the sorus and produces twin sori. If it occurs at the base of the sorus, there are two divaricate receptacles; this condition is fairly common. In all cases the sporangia are large and borne on conspicuous pedicels.

The form of the involucre is a function of the branching of the receptacle. If the latter is simple, the involucre is approximately round; this is the usual form on sparsely fruiting fronds (for example, the type). To inclose divided receptacles, the involucres are broader. If there are two receptacles, the involucre is about twice as broad as long, as described in Synopsis Filicum. There are also rare forms, between these and twin sori, with the valves deeply emarginate or cleft. Denticulate involucres, as described in the Synopsis, I cannot find: the margin is usually entire; otherwise, slightly irregular. Below the involucre, the lamina is usually but not always contracted. In full fruit, sori are produced on all or all but the distal segments, on both sides of the pinnæ.

Specimens: CHINA, Yunnan, *Henry 11545* (*H. dilatatum* var. *amplum* Christ), *Hancock 218;* Kweichow, Tsiang *6444, 7568;* Kwangsi, *Ching 5752, 5831, 6271, 6975, 7086*; Kwangtung, *Matthew 45, Merrill 10171, 11099, Levine 574, 1469, Levine and McClure 9631; Canton C. C. 12410,* det. C. Chr., veins conspicuous, *14128;* Fukien, *Dunn* (*Hong Kong No. 3911*), *Dalziel.* JAPAN, *Faurie 4639,* and without name of collector in Gray Herb. and U. S. Nat. Herb. FORMOSA, *Faurie, 305, 628,* and, det. Ro-

senstock, *14*, sterile, *285*. INDO-CHINA, *Colani 580, Pételot 3325, 3905, 4061*. PENANG, *Haniff 15106*. PENINSULA, *Kew distribution 105, Norris*. PHILIPPINES, *Cuming 112* (type coll. of *H. Cumingii*) *v. d. B., 130* (type coll. of *Sphaerocionium macrocarpum*); *Bur. Sci. 1804, 3845, 4234, 8383, 13531, 15062, 15263, 17525, 20597, 22072, 23548, 33923, 37588, 38531, 38797, 39138, 41908, 48570, 48653, 48654, 77197, 80347; Loher 1197, 13492; Matthews; Merrill 6079, 6081; Clemens 1081;* thus ranging from northern Luzon to Mindanao, mostly along the eastern side of the Archipelago.

There are a considerable number of other Philippine collections, which have been distributed as *H. Junghuhnii* but which I now feel sure are *H. badium*. The large, very broad involucres of the two species may be exactly alike; and so may the receptacles as regards their dilation and pedicels, but the widened head is on a longer stalk in well-developed *H. Junghuhnii*, and therefore stands higher in the sorus. The latter species is usually a larger, handsomer fern, a clear, deep green in color, likely to have a narrower, and never a crisped wing on the rachis, and with contracted fertile segments, the sorus therefore often appearing stalked.

Luzon specimens which have been called *H. Junghuhnii* are *Bur. Sci. 7190, 8383, 13531; Copeland 1921*, and *P. P. E. 66; Vanoverbergh 869; Topping 1160*. All of these are better referred to *H. badium;* they are brownish, several have somewhat crisped wings, and they agree better with it in form. I refer here also *Bur. Sci. 31914 Santos*, although the narrow wing and the correlated very narrow fertile laciniæ give it a very distinct appearance.

CELEBES: *Bünnemeyer 12079*.

Reported from Mount Kinabalu, Borneo, by Christensen, Gardens' Bull. S. S. 7 (1934) 214, on the strength of a sterile specimen, *Clemens 27315*. *Clemens 20412*, from Sarawak, also all but sterile, is probably this species. *Brooks 158*, Mount Penrissen, Sarawak, with many sori, all immature, seems also to be *H. badium* rather than *H. salakense* (unlike both in having pitted walls), with the stature of the latter but a slightly wavy wing. It may be that *H. badium* shades into *H. salakense* in Borneo; and it may still be expedient to recognize both of them as species.

A specimen from Riouw distributed as *H. formosum, Bünnemeyer 5927*, seems more like *H. badium*, but is intermediate in character as well as geographically. Brause, Engler's Jahrb.

56 (1920) 41, credits *H. macrocarpum* to Papua. It will be observed that I have seen no later specimen from the Himalayas, the supposed source of the type.

At this point must be considered the plants for which van den Bosch prepared, but did not publish, the description of a species to be called "polyanymos." The material was *H. dilatatum* δ Blume, and *Cuming 220,* which was *H. sanguinolentum* J. Sm. *non* Sw., and *H. crispatum* γ, *majus* Hooker, Sp. Fil. 1:105. Van den Bosch stipulated that it was *Cuming 220* in Herb. Hooker *nec alibi,* but the specimen in the Phil. Nat. Herb. is exactly the same. What purports to be the Blume specimen in Herb. Lugd.-Bat. *908, 281–738* bears two separate fronds. The one on the left is sterile, and may be *H. imbricatum.* The one on the right is fertile, and must have been the source of van den Bosch's unpublished figure, showing a deeply divided receptacle. I feel sure that an accident in the Leyden Herbarium is responsible for the presence of this frond on the Blume sheet. The pitting of the walls is characteristic, unlike any known in Java, but identical with that of our specimen of *Cuming 220,* which it surely is.

This collection has the unstable, often more or less forked, receptacle of *H. badium,* but the walls are too characteristically different to permit identification with that species.

For further reference to this plant, see *H. opacum.*

102. HYMENOPHYLLUM CRISPATUM Wallich. Plate 77.

Hymenophyllum crispatum WALLICH, List (1828) No. 169, *nomen;* HOOKER and GREVILLE, Ic. Fil. (1828) *pl. 77;* HOOKER, Spec. Fil. 1: 105; BEDDOME, Ferns S. India, *pl. 207.*

H. javanicum resp. *H. australe auct. plur.*

Erect, fronds ovato-acuminate tripinnatifid, the segments linear obtuse generally plane sometimes waved entire, involucres terminal sometimes on lateral segments copious ovate sessile free entire 2-valved to the very base the valves convex, receptacles wholly included, stipes with broad crisped wings almost to the base, wing of the rachis also crisped.

—HOOKER, Spec. Fil.

Stipe 3 to 5 cm long, winged almost to the base with a broad, crisped wing; frond 6 to 12 cm long, ovate or narrowly so, olive or brownish green, rachis winged, the wing more or less crisped, a slight overfullness usually extending to the laciniæ, which are wavy, bent, or straight, 0.6 to 1.2 mm wide, up to 5 mm long; walls uniformly thin and straight; sori on axillary or lateral contracted segments, involucre 1 to 6 mm wide, ovate to orbicular, cleft to the base, lips entire or erose, receptacle with short,

columnar sterile base, and dilated head with evident or prominent sporangiophores.

Common in the Himalayas from Nepal east; thence south to Ceylon and the Peninsula, where it overlaps the area of *H. javanicum* (from all of India it is useless to cite specimens because so few bear collector's numbers). CHINA, *Hancock 161* (mixed with *H. badium* in U. S. Nat. Herb.), *Henry 10098, Rock 7335.* LUZON, *Bur. Sci. 4556, 5443, 5807, 8511, 31914, Topping 1115, F. B. 5053, Merrill 7663, Philip. Plants 950.*

The near affinity of *H. crispatum* is not to *H. javanicum,* with which it has been confused, but to *H. badium.* When Beddome, Ferns Brit. India and Ceylon 33—not in his earlier works—reduced *H. badium* to a variety of *H. javanicum,* it was because he had already made the less reasonable mistake of merging *H. crispatum* in that species. Compared with *H. badium, H. crispatum* is smaller, more crisped, and with narrower wing, segments, and sori.

102a. HYMENOPHYLLUM PLEIOCARPUM v. A. van Rosenburgh. Plate 78.

Hymenophyllum pleiocarpum v. A. VAN ROSENBURGH, Bull. Jard. Buit. III 5 (1922) 208.

Of this plant I have authentic specimens, *Bünnemeyer 9142, 9245,* and *9313;* also *Bartlett 6542;* all from Sumatra. The wing of the rachis is only moderately crisped, and the lips of the involucre are subentire. These distinctions from *H. crispatum* seem too weak to justify specific distinction. Also, if it be held distinct, some of the Luzon specimens will seem to represent it, while others will seem to be *H. crispatum;* but they are surely all one species. Therefore, it seems best to regard *H. pleiocarpum* as a form of *H. crispatum,* perhaps established in Sumatra, but present and not established in Luzon.

103. HYMENOPHYLLUM CRISPATO-ALATUM Hayata. Plate 79.

Hymenophyllum crispato-alatum HAYATA, Ic. Pl. Formosa 5 (1915) 256.

Hymenophyllum javanicum NAKAI, Bot. Mag. Tokyo 40 (1926) 244, *non* Sprengel.

Rhizoma repens. Stipes 6–10 cm. longus a basi usque ad medium teres a medio sursum alatus cum alis 2 mm. latus, alis $\frac{2}{3}$ mm. latis, glaber. Frons ovato-lanceolata vel lanceolata 14–22 cm. longa $3\frac{1}{2}$–6 cm. lata apice acuminata basi in ambitu truncata bipinnatifida, segmentis I. mediis vel inferioribus longissimis, infimis brevioribus superioribus gradatim brevioribus minoribus, mediis oblongis 3 cm. longis $1\frac{1}{2}$ cm. latis apice obtusis basi latissimis latere superiore truncatis latere inferiore cuneatis, segmentis II. infimis mediis obovato-cuneatis apice obtusissimis basi cu-

neatis 8–9 mm. longis 5 mm. latis pinnatis, lobis linearibus apice obtusis 3–4 mm. longis 1 mm. latis; textura tenuissime membranacea glabra semihyalina; rhachis alata, cum alis 2 mm. lata, alis ⅜ mm. latis valde undulato-crispatis; rhachis segmentorum I. alata cum alis 2 mm. lata, alis partibus inferioribus undulato-crispis; segmentis inferioribus I. a se circ. 1⅓–2 cm. remotis, segmentis inferioribus II. I. vel II. siti breve stipitati, stipitibus apice constrictis; involucrum perfecte bivalvatum oblongo-rotundatum margine denticulatum.

Hymenophyllum javanicum HAYATA Ic. Pl. Formos. IV. p. 141, fig. 81, (non Spreng.).

Hab. Mt. Arisan, leg. B. HAYATA et S. SASAKI; inter Heishana et Nimandaira, leg. B. HAYATA et TAKEO ITO, Mart. 1914.

Differs from *Hymenophyllum javanicum* Spreng. by the much narrower and longer fronds with sori usually situated at the basal portions of the pinnae. Somewhat allied to *H. crispatum* (Hk. et Grif. t. 77) by the crispate wings of the stipes; but widely different from it by the lanceolate fronds with truncate valves of the involucres.—HAYATA, loc. cit.

Known from Mount Arisan only, whence I have it as *Faurie 627*.

It is like enough to *H. crispatum* in gross aspect to pass easily as that species, and it is only because its internal walls are considerably thickened and closely crenate-toothed that I abstain from reducing it.

104. HYMENOPHYLLUM FLEXILE Makino. Plate 80.

Hymenophyllum flexile MAKINO, Bot. Mag. Tokyo 13 (1899) 45.

Rhizome wiry, wide-creeping laxly branched, darkish-brown, nearly naked, rooting. Stipes loosely placed on the rhizome, slenderly elongate, wiry, hard, naked but margined with narrowly crispate wings on both sides except the lower portion, shorter than the frond, 2–9 cm in length. Frond lanceolate, or broadly lanceolate, sometimes ovate-lanceolate, shortly subacuminate, 8–25 cm long, 3–5½ cm broad, tripinnatifid or subquadripinnatifid, thin, flexible, naked, but thinly and very minutely scaly on the rachis and nerves beneath, darkish ferruginous-brown when dry; pinnae usually erect-patent, 10–14 on each side, moderately closed, or laxly distant in the superior and inferior, narrowly triangular-rhomboidal, or sometimes rhomboidal-deltoid, often somewhat falcate, broadly cuneate at the base, very shortly petioled or nearly sessile, divided down nearly to the rachis into few or several pinnules on each side, lowest ones decreasing in size, largest ones about 5 cm long, nearly 2 cm broad; pinnules cuneate-ovate, deeply divided into few simple or bifurcate segments in the lower ones, but upper ones only bifurcate or simple; ultimate segments narrowly oblong, entire, obtuse or retuse at the apex, 1⅓–2 mm broad; main rachis slender, crispato-winged throughout, each lateral wing 1 to 1½ mm in width. Sori rather copious, laxly disposed except the apical and lower portions of frond, 1 to 15 to a pinna, terminating the inner lower segments of the pinnules, rounded or broadly rounded, rounded at the base, 1½–2½ mm each way; involucre divided down to very base, naked; valves orbicular, sometimes truncate in front, erose-dentate on

front margin; sporangia numerous, clustered in capitate manner on the top of a short receptacular column, included, very shortly pedicellate, with incomplete ring.

Nom. Jap. *O-kokeshinobu.*

Hab. Prov. Kii; Mt. Nachiyama (*Z. Matsumura!* herb. Sc. Coll. Imp. Univ. Tokyo, July 25, 1883; *M. Miyoshii!* herb. l. c. Aug. 18, 1887); Prov. Tosa: Near Mt. Tebako-yama (*T. Makino!* Aug. 1885), Mt. Honokawa-yama (*T. Makino!* Aug. 10, 1887), Mt. Kurotaki-yama (*T. Makino!* Nov. 1892).—MAKINO, loc. cit.

Makino's description is good, although the axes are really not scaly, and the involucres are divided down to a very broad base; the valves are rounded or truncate, and vary from entire to rather deeply erose. The cell walls are thin and uniform. The head of the receptacle is much enlarged and moderately dilated, with the sporangia on long branches (sporangiophores, not stalks).

The species is closely related to *H. badium,* from which it is conveniently distinguished by the position of the sori, terminating many of the proximal segments of the medial part of the frond, but wanting near the apices of the frond and of the pinnæ.

Known only from Japan.

Represented in my herbarium by *Faurie 2912,* det. by Makino, *ipse* from Mount Kupisan, Kiushu; in the Phil. Nat. Herb. by *Tagawa 242,* topotypic, from Mount Nachi, Kii Province. Our illustrations are from the latter.

105. HYMENOPHYLLUM OPACUM Copeland sp. nov. Plate 81.

H. gregis H. badii lamina opaca et parietibus undulato-vittatis distinctum, rhizomate lignoso, 1.6 mm crasso, radices multas pilosas emittente, ipso glabro; stipite 5 ad 8 cm alto, 1 mm crasso, recto, fere ad basin alato; fronde ovata, ca. 15 cm alta, 8 ad 12 cm lata, subcoriacea, opaca, axibus conspicue alatis ala subundulata; pinnis erecto-patentibus, basi obliquis, sterilibus apice acutis, majoribus bipinnatifidis v. rarissime subtripinnatifidis, segmentis brevibus ca. 1.5 mm latis, plerisque emarginatis; soris in parte superiore frondis segmenta fere omnia terminantibus, involucro orbiculare, ad basin fisso valvis aut integris aut undulatis, receptaculi basi columnare sterile, capite valde et irregulariter dilatato, sporangiophoris conspicuis ubique obsito; parietibus inter cellulas laminae conspicue undulato-vittatis, marginalibus solummodo subundulatis.

NOVA GUINEA, Mount Nassau, altitude 1,500 m, *Docters v. Leeuwen 10946,* October, 1926; *Herb. Lugd.-Bat. 932.34–260,* sub *H. salakense* distrib.

The color, opacity, and shallowly dissected pinnules with contiguous segments, combine to produce an appearance suggestive of *Trichomanes obscurum.*

The pitting of the walls is not quite unique in this group, being like that of *Cuming 220,* which I discuss and illustrate under *H. badium.* Possibly that and the species here described are the same, but I cannot pass on this with the limited material. The Philippine specimen is lighter, narrower, and less divided; in a near relative of *H. badium* I do not regard the apparent difference in the receptacles as diagnostic.

106. HYMENOPHYLLUM WRIGHTII van den Bosch. Plate 82.

Hymenophyllum Wrightii VAN DEN BOSCH, Synopsis (1859) 51; NAKAI, Bot. Mag. Tokyo 40 (1926) 247.

Hymenophyllum oligosorum MAKINO, Bot. Mag. Tokyo 13 (1899) 44; NAKAI, Bot. Mag. Tokyo 40 (1926) 247.

Hymenophyllum coreanum NAKAI, Bot. Mag. Tokyo 40 (1926) 247.

Fronde late oblonga pinnatifida, laciniis patulis contiguis 1–2 dichotomis dimidiatis (?), lacinulis latiusculis abbreviatis, cellulis opacis firmis rubrofuscis magnis (imo maximis) elongato-hexaëdris acutangulis globulosis, globulis inaequalibus confertissimis diffusis, parietibus hyalinis tenuibus rectis, cellularum marginalium minute et obtuse crenulatis, soris in laciniis axillaribus reflexis lacinula latioribus e basi conica immersa bilobis, lobis semicircularibus integris, receptaculo brevi. Rhizoma horizontale ramosum setaceum paleis piliformibus elongatis crispulis parce tomentosum; stipes mediotenus ala rhacheos descendente anguste marginatus vix ultra 7 millim. longus, frons 16 millim. longa, 10 millim. lata opaca firmiuscula rubro-fuscidula.

Hab. Japonia! (Hakodadi), *Wright.*—MAKINO.

I miss the type in Herb. Lugd.-Bat., but the type collection is in U. S. Nat. Herb. and Gray Herb. and is as described.

This is a dwarf form of *H. polyanthos,* from which it differs solely in size and in features necessarily correlated with loss of size—simplicity of frond. It varies like *H. polyanthos* in shape of involucre and immersion of the base. Like dwarfs in general, it is very inconstant in shape of frond. The structure is exactly that of *H. polyanthos;* ingrowths from the marginal wall are often present in the sinuses. I illustrate it by a frond from the type collection, and two fronds on the same rhizome of *Taquet 3635.* The latter are of the size most usual in collections bearing this name. I suspect that it will be possible to find in Japan every stage between these and those recognized as *H. polyanthos* (as *H. blumeanum* or *H. integrum* of Nakai).

Of *H. oligosorum* Nakai cites four collections, all from the one type locality. I have two, *Flora Japonica s. n.,* June, 1908,

and *Flora Japonica 3*, 1914, which, having no collector's name, may or may not be the same cited by Nakai; both are without fruit. *Faurie 4643* is also received with this name. In his key, page 243, Nakai distinguishes *H. oligosorum* with "Rachis late alata. Frons infra ciliata. Lobi frondis circ. 1 mm. lati obtusi," from *H. Wrightii* with "Rachis anguste alata. Frons infra glaberrima. Lobi frondis haud 1 mm lati retusi." I find hairs on young enough fronds of *H. Wrightii*, and none on old fronds of topotypic *H. oligosorum*. The other distinctions are relative, and I do not find them nearly great enough to sanction specific distinction.

The key distinction between *H. Wrightii* and *H. coreanum* is size, the latter being more minute; therewith it is less dissected. But the type collection of *H. Wrightii* would, by Nakai's criteria, better represent *H. coreanum.*

JAPAN, *Wright, Faurie 185, 186, 944, 2624, 4644, 5259, Rosenburg 14, Hayakawa 683, Sakurai 4, Ishida.* QUELPAERT, *Taquet 3635.* Specimens bearing this name by Iishiba are *Trichomanes parvulum.*

107. HYMENOPHYLLUM EXSERTUM Wallich. Plate 83.

Hymenophyllum exsertum WALLICH, Cat. No. 171; HOOKER, Sp. Fil. 1 (1844) 109, *pl. 38A;* BEDDOME, Ferns S. India, *pl. 9*, Ferns Brit. India & Malaya *pl. 16;* CHRISTENSEN, Cont. U. S. Nat. Herb. 26 (1931) 330, *pl. 24.*

Hymenophyllum Gardneri VAN DEN BOSCH, Synopsis (1859) 77.

Hymenophyllum Delavayi CHRIST, Bull. Soc. Bot. France 52, Mém. 1 (1905) 11, *teste* Christensen.

Hymenophyllum exsertum, Wall.; flexile pendent, fronds oblong elongate acuminate pinnated, pinnae rather distant lanceolate acuminate decurrent especially the upper ones pinnatifid but not deeply, segments short linear-oblong obtuse entire simple or bifid, involucres on the upper side of the pinnae solitary or 2–3 sessile or terminating short segments ovate 2-valved almost to the base compressed, the valves eroso-serrate or nearly entire, rachis stipes and costa more or less crinite with long scattered rufous hairs. (Tab. XXXVIII. A.)—*Wall. Cat. n. 171.* H. densum, *Wall. Cat. n.* 170.

Hab. Nepal, *Wallich.*—A well-marked species. The pinnae are decurrent, broad and not deeply pinnatifid.—HOOKER, loc. cit.

On the specimens in hand, ex Herb. Musei Brit., the Wallich names reverse those cited by Hooker, *170* being *H. exsertum* and *171 H. densum,* which agrees with Wallich's "published" List; *H. densum* was never properly published.

Very variable in size, the largest and finest specimens coming from the Khasia Hills, *Mann,* more than 10 cm long and up

to 4.5 cm wide, and symmetrical, bipinnatifid with forked segments; smaller fronds with pinnæ varying in length are commoner elsewhere, and dwarfs seem not to be rare. Rhizome and stipe filiform, deciduously hairy; rachis winged throughout, or marginate or terete at the base, everywhere hairy on the nether side, the hairs 0.5 mm long but fragile and eventually deciduous, smaller hairs extending along the axes to the costæ; pinnæ remote or imbricate, lanceolate or ovate, the main veins wavy so that the branches are divaricate, but the costæ of forked segments branching at an acute angle, pinnæ pinnatifid to a broad wing or undivided middle portion, segments often narrowed to the apex; cell walls thin, slightly wavy and eventually slightly, irregularly, thickened; sori acroscopic, axillary on short or obsolete segments, the base of the involucre immersed, the lips irregular or inciso-crenate, rarely subentire, receptacle slender, included.

Throughout INDIA, Himalayan region, *Wallich 170, 171, Hooker and Thompson, Duthie 3656, Clarke 36481, 43914, Mann, Levinge, Anderson 1421, Strachey and Winterbottom;* Peninsular India, *Griffith, Gamble 18302, Noyes, Sauliere.* CEYLON, *Thwaites 1390.* YUNNAN, *Rock 7216.* SIAM, *Rock 1757, 1517* (involucre very variable). *Eryl Smith 1403* from Hainan may be this species.

Specimens bearing this name from Sumatra and the Malay Peninsula, and most of those from Ceylon, are *H. edentulum* (*H. macroglossum*), with peculiarly thickened walls and different involucre, and more glabrescent.

108. HYMENOPHYLLUM FLEXUOSUM A. Cunn. Plate 84.

Hymenophyllum flexuosum A. CUNN., Hook. Comp. Bot. Mag. 2 (1836) 369; Sp. Fil. 1: 105; GIESENHAGEN, Flora (1890) *pl. 16, fig. 15.*

Hymenophyllum javanicum part., HOOKER and BAKER, Syn. Fil. 60, *non* Sprengel.

Hymenophyllum australe part., auct. mult., non Willd.

Fronde ovata subacuminata tripinnatifida glabra, laciniis linearibus retusis apice nunc emarginatis, marginibus integerrimis undulatis, involucris orbicularis compressis solitariis geminisve, ore bilabiato integro vel emarginato, rachi stipiteque superiore alatis, alis undulatis flexuosis.

New Zealand (Northern Island). In humid forests, on decayed timber, Wangoroa.—1834, *R. Cunningham.*

Obs. This species differs from the preceding [*H. tortuosum*], its close ally, in the mouth of the involucre being wide, the lips almost altogether entire; and in the segments of the frond having no denticulations on their waved margins, which are obvious in that species. It comes also near to *Trichomanes crispatum* (Hook. t. 70); but that species is readily

distinguishable by the alated segments of its frond, not being at all undulated, and by the involucre being uniformly solitary, and of a more oval form.—CUNNINGHAM, loc. cit.

Rhizome branching and intricate, short-hairy when young, presently scurfy, finally glabrescent, woody, 0.8 mm thick; stipes up to a decimeter long, winged except at the base, wing widest at the top, 4 mm overall, the margin overfull and crisped; frond ovate or deltoid, up to 18 cm long, most ample forms quadripinnatifid and then the lowest segments forked, rachises winged like the stipe, the wing narrowing from the base upward, segments variable, commonly 0.6 mm wide, 3 to 5 mm long, entire; sinuses rounded and usually overfull; cell walls all thin, the internal ones wavy next to the surface; sori on short, usually lateral, laciniæ, involucre orbicular or narrower or broader, cleft to the broad base, the lip usually entire; receptacle with a large almost sessile head, wide and variable in width, with short sporangiophores, sporangia small. As in *H. badium,* twin sori are frequent, and forking of the axis at or above the base of the sorus results (rarely) in twin receptacles, or (often) in much dilated receptacles.

This is the New Zealand representative of the group of *H. badium,* not at all that of *H. javanicum* with which it has been confused strangely. It is recognizable at sight by the wide wing of the upper part of the stipe, with crisped margin but flat along the axis.

Endemic in New Zealand, apparently common in both islands. The best collection is by *Setchell,* five sheets in Herb. Univ. Calif. Others seen are: *Cunningham, Herb. Lugd.-Bat. 908, 280–362,* probably the type collection, small and immature; *Hooker, Brackenridge, Kirk 355, 568, Ranfft, Thompson, Bell, Holloway.*

108a. HYMENOPHYLLUM POLYCHILUM Colenso.

Hymenophyllum polychilum COLENSO, Trans. New Zealand Inst. 24 (1891) 395.

Plant terrestrial; rhizome subterranean, shortly creeping, naked, its rootlets very hairy; hairs dark-red, patent, often terminating in a minute round glandular-like ball. Frond membranous, 8 in.–11 in. high (stipe included), 3½ in.–4 in. broad at base, deltoid-acuminate, 3-pinnatifid, leafy, dark-green, suberect, slightly decurved; stipe (4 in.–5 in.) terete, glabrous, shining, rigid, more or less flexuous, dark-brown. Rhachis and subbrachises winged throughout, pinnae close overlapping, their tips often elongated, simple and forked at apices, the lower ones decurved; sometimes the second pair from base are the longest, the lowest pair opposite with their large basal segments meeting over rhachis, pre-

senting a semicrisp appearance; segments broad, laciniate; lobes narrow-linear, entire, obtuse. Involucres on all pinnae, but mostly very numerous on upper two-thirds of frond, marginal on all sides and tips of segments and lobes, very large, wider than lobe, oblate, hemispherical and oblong, 2–4-fid to base, open, spreading, sometimes 2–3 together; lips entire, truncate, broad, sometimes once notched; here and there two clusters of sori are together within one involucre. Sori prominent, much exposed; capsules large, striking, each with a bright-red shining elastic ring.

Hab. Dry shaded woods south of Dannevirke, County of Waipawa; 1890–91: *W. C.*—COLENSO, loc. cit.

Not seen; probably near *H. flexuosum*, although Colenso compares its rather with *H. demissum*, and Cheeseman has reduced it to the latter species.

109. HYMENOPHYLLUM PULCHERRIMUM Colenso.

Hymenophyllum pucherrimum COLENSO, Tasm. Journ. Nat. Sci. 2 (1844) 185; HOOKER, Sp. Fil. 1 (1844) 103, *pl. 37A*, HOLLOWAY, Trans. N. Z. Inst. 54 (1923) *pl. 61*.

Plant, climbing, fronds numerous, sub-erect, spreading, pendulous, glabrous, very membranaceous, epiphytical. *Frond*, rhombic-lanceolate, lax, margined, tripinate; grass-green. *Pinnules; primaries*, rhombic-ovate, sub-acute, petiolate, alternate, remote, unequal: *secondaries*, triangular- or trapezio-ovate, retuse, petiolate, alternate: *tertiaries*, trapeziform, cuneate, and pinnatifid: *segments*, entire, linear, bifid, emarginate and retuse. *Involucre*, small, globose, sub-pedicelled, solitary, sub-terminal in sinuses of tertiary pinnules and segments, numerous, scattered: *Valves*, large, and entire. *Rachis*, winged, 8–11 inches; margin entire. *Stipe*, semi-terete, flattish, somewhat fleshy, brittle, winged to caudex, glabrous, densely fimbriated at base; margin entire. *Caudex*, creeping.

Hab. On reclining and prostrate trees, humid woods, shores of Waikare Lake; December, 1841.

Obs. This fine and very beautiful species becomes circinnate as it gets old. In affinity it somewhat approaches *H. flexuosum, R. Cunn.;* from which, however, it may at first sight be discriminated, by its being tripinnate, and by its winged stipe and rachis being destitute of undulations, & c.—COLENSO, loc. cit.

Hooker's publication, with an inaccurate reference to Colenso's, was made in the same year.

Rhizome the stoutest in the genus, 1 to 2 mm thick, densely beset with acicular reddish-brown hairs suggesting those of typical Dennstaedtiid ferns, stipe also stout, 5 to 10 cm long, narrowly winged to the base, the wing plane; frond 20 cm long, or up to 45 cm, and then very lax, ovate or narrowly ovate, quadripinnatifid, the minor axes and segments straight or sinuous, segments 1 mm or more wide; cells large, walls eventually irregularly but not greatly thickened, marginal walls thin except in the sinuses, which are two cells thick and usually also over-

full, parenchyma two cells thick for a short distance in the axes of the veins; sori on short lateral (mostly basal) segments, slightly wider than the segments, involucre cleft to the base, in general orbicular, valves inflated, fragile, entire; receptacle with sterile base enlarged gradually to the round head with small sporangiophores, included, standing in the middle of the involucre.

NEW ZEALAND, *Kirk, Cheeseman, Brame, Ranft, Holloway, Petrie.*

110. HYMENOPHYLLUM VILLOSUM Colenso.

Hymenophyllum villosum COLENSO, Tasm. Journ. Nat. Sci. 2 (1844) 185, London Journ. of Bot. 3: 35; KIRK, Trans. New Zealand Inst. 10 (1877) 395; HOLLOWAY, Trans. N. Z. Inst. 54 (1923) *pl. 58.*

Plant, climbing, few fronded, reclinate and pendulous, glabrous, epiphytical. *Frond,* ovate, sub-acuminate, tripinnate, 3 inches long; colour, tawny green. *Pinnules; primaries,* somewhat trapezio-lanceolate, acuminate, obtuse, petiolate, alternate, unequal; midrib, sub-flexuose: *secondaries,* somewhat rhombic-ovate, obtuse, petiolate, alternate: *tertiaries,* sub-pinnatifid, cuneate petiolate, alternate: *segments,* deeply incised, 2–6 lobed: *lobes,* linear, entire, truncate or slighty emarginate. *Involucre,* ovate, sub-acute and obtuse, solitary, sometimes in pairs, axillary in axillae of tertiary pinnules and lobes, pedicelled. *Valves,* large, entire, and much open. *Rachis, Petioles,* and *Ribs,* villous underneath, and margined; margin, entire, and slightly ciliated; *Rachis,* flexuose. *Stipe,* two inches long, winged to base, brittle and villous. *Caudex,* creeping.

Hab. On reclining and prostrate trees, dense shaded forests near Ruatahuna; January, 1842.

Obs. This fern has a peculiarly strong smell, especially when dry. It appeared to be a scarce species, a few plants only being detected, and these in one locality.—COLENSO, Tasm. Journ. Nat. Sci.

Kirk's description is more complete, includes quadripinnate fronds up to 5 inches long, and makes the involucre round. The stipe is marginate in the upper part, terete near the base. The hairs are mostly deciduous with age, which explains Hooker's view, Sp. Fil. 1: 107, that it is "a subvar. [of *H. polyanthos* β *sanguinolentum*] with stipes and rachis very slightly hairy." The lamina is everywhere one cell thick. The walls are in general thin and straight, but irregularly somewhat thickened, and the internal ones finely wavy next to the surface. The receptacle has a sterile base, and an equally long, slender fertile region with prominent sporangiophores, all included.

As to affinity, Kirk says: "The affinities of our plant are with *H. polyanthos,* Swartz, and *H. demissum,* Swartz; from the former it differs in possessing longer and narrower segments

and terminal orbicular sori; it may readily be distinguished from the latter by its small size and orbicular involucres, which have entire lips and are broader than the segments. In color, texture, and the presence of hairs, it approaches *H. scabrum*, A. Rich."

Endemic in New Zealand, and only in the higher regions (above *H. sanguinolentum*). *Kirk 562, Cheeseman, Sledge, Brame, Haddrel, Holloway.*

111. HYMENOPHYLLUM AUSTRALE Willdenow. Plate 85.

Hymenophyllum australe WILLDENOW, Sp. Pl. 5 (1810) 527; HOOKER, Sp. Fil. 1:108; VAN DEN BOSCH, Synopsis 50 *part.; auct. plur. recent. parte minima.*

Hymenophyllum atrovirens COLENSO, Tasm. Journ. Nat. Sci. 2 (1844) 186. (?)

Hymenophyllum tasmannicum VAN DEN BOSCH, Synopsis (1859) 59, *teste* VAN DEN BOSCH, Ned. Kruid. Arch. 5^3 (1863) 198.

H. frondibus bipinnatis, pinnulis linearibus obtusis, inferioribus bifidis, soris terminalibus, indusis emarginato-bidentatis, rachi alata, stipite marginato. W.

Südlicher Hautfarrn. W.

Habitat in Novae Hollandiae capite Van Diemen. ♃. (v. s.) La Billardière.

Caudex repens capillaris laevis. Stipes sesqui- vel bipollicaris marginato-subanceps. Frons bipollicaris bipinnata rubicundo-fuscescens. Pinnae semipollicarse inferiores et superiores minores. Pinnulae bilineares, inferiores bifidae, laciniis linearibus obtusis, superiores simplices lineares obtusae. Sori in apicibus pinnularum solitarii. Indusia ovata apice emarginata vel obtuse bidentata. Rachis alata. W.—WILLDENOW, loc. cit.

Two important additions must be made to Willdenow's description: The wing of the axis is plane. And, underlying the adjoining halves of the marginal and the submarginal rows of cells, there is another row, making the lamina two cells thick along this line—an anatomical peculiarity long familiar in the case of *H. demissum*. This thickening is not quite everywhere present on any specimen, but is very evident on van den Bosch's fragment, ex Herb. La Bill., *Herb. Lugd.-Bat. 910, 28–84,* and on various specimens labeled *H. atrovirens*. Between these I find no valid distinction. From *H. demissum* it is distinguished by smaller size, axis winged throughout, and toothed lips of involucre—which last is probably diagnostic. The rachis might well be winged on dwarfs but not on large fronds. Material in hand is not sufficient for appraisal of the odor of *H. australe*. The type fragment has thickenings on the inside of the marginal wall, which I have not detected on other specimens.

Hooker, Sp. Fil. 1: 108, wondered that a Tasmanian species so well marked should not have been collected; but had already identified it (*leg. Gunn*) as *H. atrovirens*.

Range: Tasmania, New Zealand, Victoria?

Specimens: *La Billardière*, already cited; *Archer; Gunn*.

I am not sure that I have seen any New Zealand specimen of *H. atrovirens*. Specimens of *H. australe* ex Herb. Hooker as *H. crispatum* δ without indicated origin may be from Tasmania, but are more probably from New Zealand. I feel sure about *H. tasmanicum*, but not equally sure about *H. atrovirens* to which its author reduced it.

I can see no near affinity between *H. australe*, which seems to me to be a reduced relative of *H. demissum*, and either *H. crispatum* or *H. javanicum*.

There are specimens from Tasmania, *Kershner* and *Lucas*, and New South Wales, *Boorman*, altogether like the *Gunn* collections of *H. australe* in gross appearance, and so named, on which the supplementary marginal strand of cells can nowhere be detected. The *Boorman* specimens have also thick and pitted or toothed walls, and mostly acute involucre lips. They are far from typical *H. australe*, but I still let the name stand.

112. HYMENOPHYLLUM DEMISSUM (Forster) Swartz. Plate 86.

Hymenophyllum demissum (Forster) SWARTZ, Schrad. Journn. **1800**[2] (1801) 100, Synopsis 147, 374; SCHKUHR, Krypt. Gew. *pl. 135 c.* First figured by Hedwig (not seen).

Trichomanes demissum FORSTER, Prodromus (1786) 85.

Hymenophyllum crispatum δ, *Tasmanicum* HOOKER, Sp. Fil. **1**: 105.

Hymenophyllum Aucklandicum VAN DEN BOSCH, Ned. Kruid. Arch. **3** (1859) **53**.

T. demissum, frondibus bipinnatis: foliolis alternis strictis pinnatis: pinnis pinnatifido-dichotomis, segmentis linearibus obtusis integris: fructificationibus globosis terminalibus. F.—FORSTER, loc. cit.

Rhizome wide-creeping, woody, brown, naked, 1 mm thick; stipe commonly 10 cm tall, terete, brown; frond 12 to 20 cm long, brownish green, odorous, ovate, quadripinnatifid, lowest pinnæ not or moderately reduced, rachis winged upward, naked or marginate near base, wing raised but not crisped; pinnules often shallowly incised, leaving an intact base and middle area, segments about 0.7 mm wide, 2 to 4 mm long; margin two cells thick in the sinuses and often along the whole margin; sori commonly paired, not rarely fused, simple sori usually only as wide as the segments with narrowly to broadly ovate involucre,

cleft to the broadly cuneate or horizontal base, the lips entire or, less commonly, crenate, fused sori varying from orbicular with emarginate lips and forked receptacle, to much broader, with deeply cleft lips and two separate receptacles; receptacle broadly clavate, densely beset with prominent sporangiophores.

Very variable in dissection and in form of sori, but well characterized by the two-layer marginal strand, and by the odor, which is that of *H. sanguinolentum* but not so strong; in both respects utterly unlike the Malayan *H. productum* with which it has been confused. Most simply and commonly, this strand is formed by a single row of cells underlying the adjacent halves of the marginal and the submarginal rows of cells. For a discussion of the various modifications of this structure (some of which I have not verified), see Mettenius, Hymenophyllaceae, pages 458, 459. The first observation of the variable sori is credited to Hedwig.

New Zealand, apparently common (there are twenty sheets in U. S. Nat. Herb.) and always correctly named. With the type material of *H. aucklandicum* in hand, I can distinguish it in no way from a small *H. demissum; H. sanguinolentum* is a local relative; *H. australe* is a related dwarf.

113. HYMENOPHYLLUM DILATATUM (Forster) Swartz. Plate 87.

> ***Hymenophyllum dilatatum*** (Forster) SWARTZ, Schrad. Journ. **1800**[2] (1801) 100; Synopsis 147, 373; SCHKUHR, Krypt. Gew. 131, *pl. 135;* HOOKER and GREVILLE, Ic. Fil. *pl. 60.*
> ***Trichomanes dilatatum*** FORSTER, Prodromus (1786) 85.
> *Sphaerocionium dilatatum* PRESL, Hymen. 35.
> ***Diploophyllum dilatatum*** VAN DEN BOSCH, Synopsis 77.
> *Leptocionium sororium* PRESL, Epim. (1849) 21, *pl. 11.*

T. dilatatum, frondibus subbipinnatis: pinnis alternis dichotomis decurrentibus cuneiformibus incisis, fructificationibus binualuibus orbicularibus inflatis. F.—FORSTER, loc. cit.

A large fern, for the genus, with stipe commonly 10 cm long and frond up to 30 (or even 45) cm by 10 to 15 cm wide, rachis winged throughout or only marginate at the base; pinnæ ovate with broad oblique base, acute or acuminate, bi- or tripinnatifid, with short, oblong segments 2 mm wide, entire, the lamina 3 (or 4) cells thick; sori terminal on any except the terminal segments of the pinnæ, in the upper part of the frond, involucre with base immersed, as wide as the segments or slightly wider, deeply divided, with entire valves; receptacle with sterile base, thence gradually widened to the very large globose fertile por-

tion, or the sterile base rarely inflated, sporangia on very short and inconspicuous protuberances.

Common in New Zealand. As every New Zealand specimen I have seen is correctly named, it is unnecessary to cite collections. Swartz and Schkuhr cite "Ins. Maris Pacifi" as the source of Forster's collection. Hooker, Sp. Fil. 1: 104, cites New Zealand, and I feel sure that he is correct. I have seen no specimen from any other place, although specimens so named in error are countless.

The infallible distinctive character is the thickness of the frond. This was recognized by Müller, van den Bosch, Mettenius (p. 461), Prantl (p. 23), and Giesenhagen, Flora (1890) 457, but it has not restrained almost all more recent writers from using this name for ferns with the typical family structure.

Leptocionium sororium Presl is described as having a clavate receptacle, a half longer than the involucre. The receptacle very nearly always falls short of the top of the valves. It is not unusual for the sporanges to protrude. By examining many specimens I have found two instances in which the receptacle itself protrudes. One of these, *Cheeseman 305, U. S. Nat. Herb. 816091*, is a freak frond with most of the major axes conspicuously elongate; the elongate receptacle conforms to the elongate segments. It is not to be regarded as specifically distinct. *Hymenophyllum sororium* van den Bosch, Synopsis 55, is not this species except as to the name-bringing synonym.

114. HYMENOPHYLLUM SCABRUM A. Richard. Plate 88.

Hymenophyllum scabrum A. RICHARD, Fl. Nouv. Zél. (1832) 90, *pl. 14, fig. 1.*
Sphaerocionium scabrum PRESL, Hymen. (1843) 126.
Diploophyllum? scabrum VAN DEN BOSCH, Synopsis 77.
Sphaerocionium glanduliferum PRESL, Epim. (1849) 22, *pl. 12.*

H. stipite ramoso rachique piloso-scabris; frondibus elasticis, lanceolatis pinnatis acutis; pinnis subbipinnatifidis; laciniis linearibus obtusis glabris, saepius apice bifurcatis; indusiis terminalibus obtusis, denticulatis bivalvibus.

Crescit ni Nova-Zeelandia. (D'Urville. v. s. s.)

Descriptio.

Stipes teres, 5–6 uncialis, piloso-scaber; frons elastica oblongo-lanceolata, 8–9 uncias longa, acuta, pinnata; pinnis alternis lanceolatis profunde bipinnatifidis; laciniis linearibus obtusis, saepius apice bifurcatis, glabris, nervo medio ejusque ramificationibus piloso-scabris, pilis raris; rachi partiali alata.

Indusia terminalis sessilia orbiculari-compressa, bivalvia, valvis obtusis, usque ad basin liberis, margine irregulariter denticulatis. Columna centralis valvulis brevior, apice ramosa et capsulas annulatas pedicellatas gerens.

Observations.

Par son extrême élasticité et par sa forme générale, notre espèce se rapproche assez de l'*Hymenophyllum elasticum* de Willdenow, trouvé dans les îles de France et de Bourbon par M. Bory de Saint-Vincent. Mais elle en diffère par plusieurs caractères, et entre autres par son stipe couvert de poils très-raides, par ses pinnules beaucoup plus elongées, plus écartées, glabres et non velues et ciliées. Elle a aussi quelques rapports avec l'*Hymenophyllum nitidum* Rob. Brown, mais s'en distingue par sa taille beaucoup plus grande, par ses stipes scabres, par ses pinnules bipinnatifides, etc.—RICHARD, loc. cit.

A distinct species, well characterized by its author. The remarkably coarse, "articulate" hairs of rhizome and stipe distinguish it from all other species. These are more or less deciduous, their more persistent bases at the base of the stipe being responsible for the specific name. Much reduced, the hairs extend along all axes, even to the costæ of the segments, on the nether surface. Presl, describing his *S. glanduliferum,* says, "Species singularis ob paginas frondis diversas." As noted by both van den Bosch and Mettenius, the lamina is three cells thick, in the manner of *H. dilatatum,* with the cells of the middle layer larger than those of the surface. Giesenhagen, Hymen. 457, construes this as an organ for the storage of water. Herbarium specimens are strongly scented, like *H. sanguinolentum.*

The lips of the involucre, when young, probably always bear glandular teeth (cf. Presl, Epim., pl. 12); but these are deciduous, leaving the lip denticulate, as described by Richard, or "scarcely denticulate" (Hooker, Sp. Fil. 1: 110). The large-capitate receptacle is included; but the lips do not nearly enclose the large mass of the mature sporangia.

New Zealand, all collectors. A specimen in the Gray Herb., *Prince,* is ascribed to Fiji, where it surely is not indigenous.

SPECIES NOT SEEN NOR PLACED

HYMENOPHYLLUM BALANSAE Fournier, Ann. Sci. Nat. V **18** (1873) 265.

Said to be near *H. Deplanchei,* and distinguished by having an entire margin; this would make it like *H. Baileyanum.* But it is also said to have an involucre cleft almost to the base, and an included receptacle. New Caledonia.

HYMENOPHYLLUM STREPTOPHYLLUM Fournier, Ann. Sci. Nat. V 18 (1873) 266.

Frond linear, 10 to 12 cm long, the distal pinnules bifid, involucre cleft to the base, valves oval-elongate, lips obscurely erose-denticulate. New Caledonia.

HYMENOPHYLLUM PUELLUM Cesati, Rend. Accad. Napoli 16 (1877) 28, 24.

"Sterile, certe juvenile. An generis?" New Guinea.

HYMENOPHYLLUM RINGENS Christ, Ann. Jard. Buit. II 4 (1904) 34.

Said to be in the group of *H. rarum,* and to differ from *H. praetervisum* in being entire. The impression I get from the description is that it belongs in the small group of *Meringium* species having entire margins.

7. Subgenus CRASPEDOPHYLLUM Presl

Hymenophyllum § *Craspedophyllum* PRESL, Hymen. 125.
Pachyloma VAN DEN BOSCH, Versl. Akad. Wet. Amsterdam 11 (1861) 318, *non* DE CANDOLLE (1828).

A monotypic "group," probably derived from *Mecodium,* characterized by a specialized marginal row of cells with black contents. A dwarf plant of New South Wales, reported also in Tasmania.

115. HYMENOPHYLLUM MARGINATUM Hooker and Greville. Plate 89.

Hymenophyllum marginatum HOOKER AND GREVILLE, Ic. Fil. 1 (1828) *pl. 34.*

Frondibus erectis di-trichotomis laciniis linearibus obtusissimis subundulatis marginatis integerrimis, involucris terminalibus solitariis rotundatis marginibus incrassatis integerrimis.

Hab. In Nova Hollandia, prope Port Jackson, inter Muscos. *Fraser.*

Caudex gracillimus, filiformis, pilosus repens.

Stipes duas tres lineas longus, erectus, filiformis, basi pilosus.

Frondes pollicares, sesquipollicares, di-trichotomae, membranaceae, pulcherrime reticulatae, areolis minutis rotundatis, costatae, basi attenuatae, lacinis linearibus, subundulatis marginatis, integerrimis, apice, *frondium sterilium,* obtusis, *fertilium* emarginatis.

Sori in sinu, ad apicem laciniarum, solitarii.

Involucrum rotundatum, bivalve, valvis subconvexis reticulatis integerrimis, marginibus incrassatis pulcherrime rubris.

Receptaculum filiforme, involucro brevius, apice, liberum.

Capsulae rotundatae, compressae, peltatae, annulatae, annulo integro.—HOOKER and GREVILLE, loc. cit.

This was remarkably well described, for its time.

In hand are a type fragment in Herb. Lugd.-Bat. and a collection by *Watts* in U. S. Nat. Herb. Simple fronds may bear sori; they are mostly about 2 cm long and 1.5 to 2 mm wide. The older internal walls are wavy-thickened.

The remarkable black border of an otherwise very distinct species led Presl, Hymen. 125, to establish for it a section, *Craspedophyllum,* with the remark that it would probably constitute a genus; for which van den Bosch proposed a new name, *Pachyloma.*

Reported in Tasmania, as well as in New South Wales.

Specimens: NEW SOUTH WALES: *Watts, Baüerlein.*

8. Subgenus SPHAEROCIONIUM (Presl)

Sphaerocionium PRESL, Hymen. (1843) 125, as genus.

Margin ciliate with stellate hairs—either stellate as several springing from one marginal cell, or with a stalk cell bearing branches at its apex; margin entire except as the hairs may arise from obscure projections—at any rate not serrate; cell walls usually thin, uniformly thickened if thickened at all, chloroplasts very small and numerous; sori immersed in the apices of otherwise unmodified segments, involucre with a broadly cuneate or rounded or truncate (or even cordate) base, cleft to where the sides of the base meet the sides of the segment, with short, broad, ciliate lips, receptacle included.

Tropics and South Temperate Zone of both hemispheres, most abundant in the American Tropics.

The type of the group, of Presl's genus, is *Hymenophyllum hirsutum* Swartz, described from Jamaica, wide-spread in tropical America, and accredited to Africa. I have seen no African specimen and mistrust its occurrence there. Presl's genus was characterized essentially by the receptacle. It comprised three sections—with margins with stellate hairs, with simple hairs, and hairless. I include in the group at least a part of the second section; but none of the third, which was an assemblage of very diverse elements.

The species treated here all have fronds pinnate in plan. As in many of the groups of this family, dwarfing occurs in this one; and, as in other groups, this dwarfing involves the loss of characteristics, in form, and eventually in structure. The dwarf derivatives of *Spaerocionium* are omitted here because they have been treated collectively in my Trichomanes, under the group "5. *Microtrichomanes,*" pp. 153–163. Of the species there treated,

"*T.*" *Lyallii* is altogether a *Sphaerocionium,* and was properly first named *Hymenophyllum.* "*T.*" *palmatifidum* clearly belongs with it, and has once been named as a *Hymenophyllum*—*H. borneense* Hooker, Synopsis (1866) 62. "*T.*" *Ridleyi* is its near relative. "*T.*" *sibthorpioides* has this and several other specific names in *Hymenophyllum. Trichomanes digitatum, T. dichotomum,* and *T. taeniatum,* in spite of more *Trichomanes*-like involucres, probably go with the foregoing; any kind of ciliate margin is out of place in *Trichomanes. Trichomanes nididulum* and *T. Francii* are without marginal hairs, but their ancestors probably did have them. Thus the whole of the group, *Microtrichomanes,* as I used the term (not as Prantl used it), belongs rather in *Hymenophyllum,* as that term is used here.

Reduction has gone still farther in this group. "*T.*" *barklianum* and "*T.*" *liberiense* are derivatives of *Sphaerocionium,* reduced to simple fronds. Most Hymenophyllaceæ with simple fronds are trichomanoid, having some kind of false veins, which would be as foreign a feature in *Hymenophyllum* (or *Sphaerocionium*) as marginal hairs in *Trichomanes.*

Key to the species of the subgenus Sphaerocionium.

Hairs absent on laminar surface.
  Hairs mostly simple, though tufted.
    Laminar cells small. (Mauritius and Bourbon.) 116. *H. hygrometricum.*
    Laminar cells large. (Hawaii.) .... 117. *H. lanceolatum.*
  Hairs with a very short stalk-cell. (Madagascar.) .... 118. *H. Poolii.*
  Hairs with an elongate stalk-cell.
    Rachis and stipe winged. (Madagascar et al.) .... 119. *H. ciliatum.*
    Stipe terete.
      Segments up to 1.5 mm wide.
        Hair-branches few, ascending. (Hawaii.) 124. *H. obtusum.*
        Hair-branches spreading, mostly 4 or more.
          Involucre roundish.
            Rachis mostly winged. (Malaya.) 122. *H. pilosissimum.*
            Rachis mostly terete. (Madagascar et al.) 120. *H. capillare.*
          Involucre very short. (South Africa.) 121. *H. Marlothii.*
      Segments about 2 mm wide. (New Guinea.) 123. *H. subobtusum.*
Hairs present on laminar surface.
  Rachis broadly winged. (West Africa.) .... 125. *H. splendidum.*
  Rachis largely terete. (New Zealand.) .... 126. *H. ferrugineum.*

116. HYMENOPHYLLUM HYGROMETRICUM (Poiret) Desvaux.

Hymenophyllum hygrometricum (Poiret) DESVAUX, Prod. (1827) 333.

Trichomanes hygrometricum POIRET in Lam. Enc. 8 (1808) 79.

Hymenophyllum elasticum Willd., Sp. Pl. 5 (1810) 520; HOOKER and GREVILLE, Ic. Fil. *pl. 135*.

Sphaerocionium elasticum PRESL, Hymen. 126.

Hymenophyllum flavo-aureum BORY, in Bélanger, Voyage, Bot. 2 (1833) 84.

Trichomanes frondibus subbipinnatis, foliolis alternis, pinnatifidis; pinnulis incisis, obtusis; surculis reptantibus, tomentosis. (N.)

Cette espèce a été recueillie par M. de Petit-Thouars, a l'île de Madagascar. (V. f.)—POIRET, loc. cit.

Stipe 4 to 8 cm long, firm, terete, glabrescent; frond 8 to 15 cm long or longer, usually narrowly ovate, acuminate, tripinnatifid, rachis winged toward the apex only, clothed with deciduous, mostly tufted, rarely branched hairs; segments short (pinnules therefore with uncut middle area), 0.6 to 0.9 mm wide, ciliate, the hairs in clusters of 4 to 6 from a discolored but not salient marginal cell, simple, costæ similarly setose, more densely beneath, and with some branched hairs; cells small with very thin, even walls; sori terminal on any segments, involucre not wider than the segments, hardly 1 mm long including the hairs, cleft to the broadly cuneate or subtruncate base, lips short, broadly rounded, ciliate with simple or stellate hairs.

Hymenophyllum hygrometricum and *H. elasticum* were identical. *Hymenophyllum flavo-aureum* was supposed to be larger, peculiar in color, and less elastic; it does not seem to be even varietally distinguishable. *Hymenophyllum telfairianum* Wall., List No. 168; Hooker Sp. Fil. 1 (1844) 113, is listed as another synonym (Kuhn, Fil. Afric. 40), but should be regarded as a *nomen nudum* of unknown application.

Specimens: *Bory*. MAURITIUS, *Sieber, Syn. Fil. 78, Fl. Mixta 294, Commerson, Person, Bewsher*. BOURBON, *Vieillard and Deplanche*.

116a. HYMENOPHYLLUM FULVUM van den Bosch.

H. fulvum VAN DEN BOSCH, Ned. Kruid. Arch. 5^3 (1863) 196.

Sphaerocionium hirsutum Herb. Reg. Berol. (non Pr.). Fronde e basi latiore oblonga vel ovato-oblongo superne bipinnatifida, inferne pinnata, pilis fulvo-ferrugineis variis vestita; laciniis superioribus e basi cuneata oblongis erecto-patulis leviter contiguis pinnatifidis, inferioribus elongatis basi latioribus patulis remotis, rhachi inferne nudâ subpinnatis, cunctis per paria approximatis; secundariis superne simplicibus dichotomisve, inferioribus pinnatifidis, lacinulis simplicibus latis minute denticulatis, denticulis piliferis, pilis stipitatis radiatis furcatisve; rhachi universali et pinnarum partiali inferiorum a medio deorsum terete setaceo pilis elongatis laxe ob-

sesso, venis venulisque validiusculis nigrofuscis; cellulis opacis vel centro nebuloso-diaphanis mediocribus inaequalibus elongato-hexaëdris, parietibus opacis fuscis rectis, interaneis grumulosis e flavescente fuscis s. totam cellulam implentibus spissis, s. lumen oblongum diaphanum relinquentibus dilutioribus, marginalibus parvis semihexaëdris; soris in lacinulis laciniarum superiorum terminalibus parvis lacinulis angustioribus, indusio e basi plus minusve rotundata cupuliformi subbilobo, lobis parum productis rotundatis integris longe ciliato-pilosis; stipite terete flexuoso fusco glabrescente 6 centim. longo. Rhizoma-, frons 1 decim. et ultra longa, supra basin 5, apicem versus 1½ centim. lata e fuscidulo olivacea membranacea tenera diaphana hygroscopica, lacinularum latitudo = 1 millim.

H. lanceolatum consimile differt: fronde lanceolata universe minus divisa, lacinulis duplo angustioribus pilis simplicibus furcatisve succineis, cellulis vix elongatis, perietibus diaphanis tenuissimis, interaneis rubrofuscis soris duplo majoribus, indusio e basi cuneata bilobo, lobis productis semi-circularibus parce ciliatis, etc.

Hab. Madagascar, (Herb. Berol. sine inventoris nomine).

—VAN DEN BOSCH, loc. cit.

The type is *Herb. Lugd.-Bat. 910.28–32*, a complete frond in full fruit, but too old and worn to afford sure judgment of its original pubescense. It differs from *H. capillare*, to which it has been reduced, in form, texture, structure, and pubescense, and is in all respects more like *H. hygrometricum*. When the sole datum regarding a specimen is its land of origin, there is a fair chance that even that is erroneous.

117. **HYMENOPHYLLUM LANCEOLATUM** Hooker and Arnott.

Hymenophyllum lanceolatum HOOKER and ARNOTT, Bot. Voy. Beechey (1832) 109.

Fronde lanceolata (3-pollic, badia) pinnata, pinnis ovato-lanceolatis bipinnatifidis, laciniis linearibus obtusis erecto-patentibus marginibus pilosis, pilis erectis simplicibus solitariis vel subfasciculatis, stipite terete hirsuto, rachi superne alata, indusiis subrotundis compressis longe ciliatis lacinias laterales terminantibus.

This is distinguished by its dark brown colour, the lanceolate circumscription of the frond, with erecto-patent divisions, fringed with upright hairs, and the ciliated nearly orbicular, indusia.

(Sandwich Islands)—HOOKER and ARNOTT, loc. cit.

Fronds commonly 5 to 10 cm long (*Hitchcock 13988* contains one frond 18 cm long), ovate, sparingly tripinnatifid, rachis terete at the base, narrowly winged farther up, setose, the hairs sometimes once forked, segments up to 1 mm wide, ciliate with simple (very rarely forked) once-jointed setæ about 0.5 mm long, most commonly in tufts of 2, sometimes solitary or ternate, often strictly appressed to the margin, the costæ similarly setose but the setæ usually solitary; cells large, with exceedingly thin walls; sori on the ends of lateral pinnules of the upper pinnæ,

involucre somewhat broader than the segment, roundish, base rounded and short-winged, with a few setæ on the back, cleft to the wing, lips closely ciliate with solitary setæ, receptacle short, globose.

Endemic in Hawaii—many collections on Kauai, Oahu, and Hawaii.

118. HYMENOPHYLLUM POOLII Baker.

Hymenophyllum Poolii BAKER, Journ. Linn. Soc. Bot. 15 (1876) 413; CHRISTENSEN, Dansk Bot. Arkiv. 7 (1932) 11.

Rhizome thread-like, wide-creeping. Stipe $1\frac{1}{2}$–3 in. long, filiform, thinly beset with fine spreading hairs. Frond lanceolate, 2–3 pinnatifid, 3–5 in. long, $\frac{3}{4}$–$\frac{7}{8}$ in. broad. Pinnae sessile, rhomboid, erecto-patent, $\frac{1}{4}$ in. broad, cuneate-truncate on the lower side at the base, cut down to a distinct wing into close, ligulate, erecto-patent, one-nerved segments $\frac{1}{8}$–$\frac{1}{3}$ in. long, $\frac{1}{3}$ line broad, only the lowest anterior ones in the most fully developed pinnae forked. Texture very thin, delicate, and elastic. Hairs on the edge and ribs abundant, often conspicuously stellate. Main rachis filiform at the base, winged above the middle. Sori many to a pinna, terminal. Valves of the involucre hemispherical, densely pilose.

Most like the slender varieties of *H. subtilissimum*, but the frond different in shape, and the secondary segments much longer and fewer.

(Madagascar.)—BAKER, loc. cit.

This is represented in U. S. Nat. Herb. by *Perrier 7514*, bearing Christensen's note "typical t. sp. orig. Kew." The rachis is terete above the lowest pinnæ, elsewhere winged. The hairs on margin and costa are branched at the top of a very short basal cell; they may be solitary but are more commonly binate; the branches are 2 to 5. A common but not constant arrangement is that from one marginal cell there spring two hairs; one closely appressed to the margin, with two branches; the other, reflexed over the lamina, or growing in any direction, with four—less commonly, five—branches. Cells large, with thin, straight walls. Sori as wide as the segments, the sides of the tube forming a right or obtuse angle at the base.

Endemic in Madagascar.

119. HYMENOPHYLLUM CILIATUM Swartz.

Hymenophyllum ciliatum SWARTZ, Schrad. Journ. 1800[2] (1801) 100 (not seen); Syn. Fil. (1806) 147; CHRISTENSEN, Dansk bot. Arkiv. 7 (1932) 12.

Sphaerocionium ciliatum PRESL, Hymen. 126.

Hymenophyllum boryanum WILLDENOW, Sp. Pl. 5 (1810) 518; HOOKER, Sp. Fil. 1 (1844) 89, *pl. 31, c.*

Sphaerocionium boryanum PRESL, Hymen. 126.

H. ciliatum, frond, bipinnatis deltoideis, pinnis decurrentibus, pinnulis linearibus obtusis subbipartitis ciliatis; stipite marginato. Fl. Ind. occ. p. 1753. Hedw. fil. ic.

Jamaica.—SWARTZ, Synopsis 147.

This was described from Jamaica but is accredited to all tropical America, tropical and South Africa, the islands of the Indian Ocean, Sikkim, and New Zealand. From South Africa, Sikkim, and New Zealand I have seen no specimen. The plant of Madagascar, Mauritius and Bourbon is *H. boryanum,* which I find it impractical to distinguish from the typical plant of Jamaica. Hooker, loc. cit., noted their similarity but thought the shape of the involucre was distinctive. In *H. boryanum* this is usually round with a round base; but the base is sometimes truncate, rarely obliquely cordate. In typical *H. ciliatum,* the cordate form, whether equal-sided or oblique, is commoner, but round bases are not rare. Form of frond, pubescence, and texture are identical.

Stipe about 2 cm long, broadly winged in the upper part; frond about 5 cm long (sometimes much larger), ovate, varying to deltoid and lanceolate, bipinnatifid with the larger pinnules forked (large forms more divided), rachis broadly winged, segments 1 to 1.5 mm wide (1 mm in Jamaica) ciliate with branched hairs borne on basal projections of the margin which leave it denticulate after the hairs are lost, hairs with a basal cell more or less one-third the length of the hair and discolored red at the apex, whence spring most commonly three divaricate or horizontal branches, similar hairs on rachis and costæ; cells large, with thin walls; sori cleft to the base or nearly so, lip of the involucre densely ciliate with simple and branched hairs, receptacle clavate-cylindrical, hardly as long as the involucre, with prominent sporangiophores.

Specimens: MADAGASCAR, *Goudot,* fragment in Herb. Lugd.-Bat., *Hildebrandt 4182, Forsyth-Major 203, Humbert 6444* (Christensen says this is the commonest local species). MAURITIUS, *Ayres, Sieber Syn. Fil. 139, Fl. Mixta 293, Person.* BOURBON, *Commerson.* KAMERUN, *Zenker 3881.*

119a. HYMENOPHYLLUM BOUTONI Baker.

Hymenophyllum Boutoni BAKER, Fl. Mauritius and the Seychelles (1877) 462.

Stipe under an inch long, winged at the top. Frond lanceolate, bipinnatifid, 2–3 in. long, ⅜–½ in. broad, thinly pilose, with the main rachis distinct-

ly winged throughout. Pinnae cuneate-deltoid, the lower consisting of 4–6 ascending entire segments, which are $\frac{1}{8}$–$\frac{1}{6}$ in. long by $\frac{1}{24}$ in. broad. Sori many to a pinna, terminal on all the segments, and broader than they are. Involucre immersed at the base, densely matted with ferruginous hairs; valves semicircular.

Mauritius, *Bouton!* Endemic. Intermediate between *H. ciliatum* and *lineare*, with the narrow frond and cutting of the latter, and the winged main rachis and large involucre of the former.—BAKER, loc. cit.

I have seen no specimen of this, and for this reason hesitate to reduce it; but there is nothing in the description to distinguish it from a narrow form of *H. ciliatum*, well known in Mauritius.

120. HYMENOPHYLLUM CAPILLARE Desvaux.

Hyenophyllum capillare DESVAUX, Mém. Soc. Linn. Paris 6 (1827) 333; CHRISTENSEN, Dansk bot. Arkiv. 7 (1932) 12.

Hymenophyllum pendulum BORY, in Bélanger, Voyage, Bot. 2 (1833) 81, *pl. 8, fig. 2.*

Sphaerocionium pendulum PRESL, Hymen. 126.

Frondibus subtripinnatifidis; pinnis infimis remotis, raris; pinnulis utrinque pilosis subpalmato-pinnatifidis; laciniis denticulatis obtusis subcontiguis; rachi sinuosa, nuda, capillari, hirsuta. Trich. hirsutum Du Pet.—Th., Flor. Trist. d'Acug., p. 34. Excl. syn. L. Crescit in insula Tristan-d'Acugna. Proximum Trichom. tricophylli sed laciniis latioribus basi magis decurrentibus.—DESVAUX, loc. cit.

HYMÉNOPHYLLE PENDANT Hymenophyllum (pendulum). *Fronde lineari dependente, pinnata, pinnulis alternis hirsuto-sericeis, cuneato-subdeltoideis, profunde laciniatis, laciniis obtusis extremitate fructiferis.*

Habitat. Les hautes forets de l'île de Mascareigne.—BORY, loc. cit.

I give Bory's diagnosis; being sure of his plant, but not of Desvaux's, retaining Desvaux's name in deference to usage. *Hymenophyllum fulvum* van den Bosch has been regarded as another synonym, incorrectly in my opinion. Presl's name must apply to Bory's plant, but Presl misplaced it, among species with simple, not stellate, hairs.

Stipes 3 to 6 cm long, terete, filiform, clothed with partly deciduous branched hairs, fronds up to 40 cm or more long, 3 cm wide, bipinnatifid with the larger pinnules once or twice forked, rachis terete almost to the apex, hairy, segments 2 to 3 mm long, about 0.8 mm wide, margins and costæ densely beset with branched hairs, with short or long stalk cells, 3 to 5 branches and a total length reaching 0.5 mm or more. Cells large, moderately elongate, with rather thin walls; sori on any segments of the upper part of the frond, as broad as the segment, a scant millimeter long, involucre cleft to the broadly cuneate or truncate base, immersed in hairs, the lips rounded, closely dentate with teeth bearing long, branched hairs.

Specimens: MADAGASCAR, *Bory* (fragment in Herb. Lugd.-Bat. ex Mus. Paris), *Hildebrandt 1848*. EAST TROPICAL AFRICA, *Stolz 873, Daubenberger-Rosenst. Fil. Afr. or. germ. n. 2.*

Christensen reports a Madagascar form, *Perrier*, with fronds 10 cm long, 1 to 1.5 cm wide, with remote pinnæ "deeply cleft into 2–3 spreading lobes." Still less-developed plants, *Pollen and van Dam,* called var. *minor* by Rosenstock, are probably young sporelings. In normal fronds, the lowest pinnæ are remote, but all others are close or imbricate.

121. HYMENOPHYLLUM MARLOTHII Brause.

Hymenophyllum Marlothii BRAUSE, in Fedde's Repert. 11 (1912) 112.

Rhizoma longe repens, filiforme, juventute pilis fulvis stellatis instructum denique glabrescens, interstitiis 0,5–3 cm longis folia petiolata emittens. Petioli filiformes usque ad 5 cm longi pilis iis rhizomatis aequalibus muniti. Laminiae ambitu lanceolatae vel subdeltoideae usque ad 12 cm longae 3 cm latae, utrinque pilis stellatis vestitae, subtripinnatifidae, pellucidae, membranaceae; pinnis 4–12-jugis, usque ad rachim fere pinnatipartitis, patentibus, ambitu rhombeis, subcontiguis, alternis, medianis maximis 2 cm longis, cr. 0,6 cm latis, inferioribus paulum decrescentibus remotisque, superioribus in apicem obtusiusculum succedaneo-desinentibus, usque ad costam 0,9 mm alatam pinnatifidis vel bipinnatifidis; segmentis usque ad 3-jugis, linearibus vel pinnatifidis, alternis, margine integro vel levissime undulato pilis stellatis densis instructis; laciniis linearibus usque ad 1 cm longis, plus minusve 1,3 mm latis, obtusiusculis; rachibus costisque validis cr. 0,9 mm alatis utrinque pilis stellatis densis praeditis; nervis validis simplicibus vel furcatis prominentibus. Sori superiorem laminae partem occupantes exigui, laciniarum apicibus impositi. Indusium minimum, cupuliforme, 0,8 mm latum, 0,4 mm longum, pilis dense obtectum.

Peninsula Montis Tabularis, in saxosis umbrosis humidis silvarum, Skeleton ravine, 500 m. ü. d. M. (R. Marloth no. 5169.—Juni 1912.)

—BRAUSE, loc. cit.

The Herbarium Lugduno-Batavum has *Marloth 1751,* antedating the type collection by nearly 25 years, and *Wilms 3926;* the former fruiting freely. These specimens fall far short of the size given by Brause, the largest frond being 5 cm long, and correspondingly less divided. The hairs are like those of *H. pilosissimum,* long, and with a long basal cell. Thus their stellate distal parts are scattered over the (mostly nether surface of the) lamina, but none originate there; they are mostly binate along the margin, solitary along the veins, and have commonly 4 or 5 branches. The laminar cells are large, with thin walls, and a thin layer of dense material closely appressed to them, leaving most of the area perfectly transparent. The sori are variable, sometimes as small as described by Brause, some-

times as wide as the segments, always relatively short, setose, and the lips ciliate with mostly forked hairs.

The short involucres provide the only convenient distinction from *H. pilosissimum.*

Endemic in South Africa.

122. HYMENOPHYLLUM PILOSISSIMUM Christensen.

Hymenophyllum pilosissimum CHRISTENSEN, Gardens' Bull. 7 (1934) 213.

H. obtusum Bak. 1879: 38, Copel., Keys 307.—*H. obtuso* Hook. et Arn. Hawaiiensi species proxima et cum ea ab auctoribus false conjuncta, differt: majori; stipite exalato ad 3–4 cm. longo; lamina elongato-lanceolata, ad 10 cm. longa, 2 cm. lata, bipinnata-tripinnatifida, supra sparse subtus densissime pilis stellatis molliter lanosa, rachi costique late alatis, segmentis 1 mm. latis.

Kinabalu, s. l. (Burbidge, type, Kew), Lumu Lumu to Kamborangah, on under sides of sloping tree trunks in mossy forest (H. 25460), Kamborangah (Cl. 28983).—Dutch Borneo: Kemul (Endert 4232, p. p.).—Papua: Hunsteinspitze (Ledermann 8460).

Among the species of the group of *H. ciliatum*, this is perhaps the most densely hairy. The undersurface is throughout covered with stellate hairs which bear, on the tip of a central stalk, 4–6 simple horizontal or suberect branches. In *H. obtusum* the midrib and margins only bear the stellate hairs; our species is more narrowly lanceolate in outline, somewhat narrowed toward the base and the apex, though the apex may be sometimes rounded-obtuse. The sori are placed on the tips of the upper segments, the indusia almost as wide as the segments, divided nearly to the base, the valves rounded, densely hairy, sporangia very large.

To this species belong, I think, all other Malayan and Melanesian specimens called by other authors *H. obtusum* and *H. subtilissimum.*

—CHRISTENSEN, loc. cit.

The stated distinctions from *H. obtusum* are not very satisfactory. Thus: *H. pilosissimum* is usually larger, and almost always more slender; but there are Hawaiian collections which match *H. pilosissimum* in these respects, and Philippine collections which match *H. obtusum.* The stipe of adult *H. obtusum* is likewise wingless, and the rachis of *H. pilosissimum* is often terete near the base. The nether surface of *H. pilosissimum* is indeed covered by stellate hairs, but Hooker's eye was truer when he wrote of *H. obtusum* (Sp. Fil. 1: 93): "Hairs copious, confined to the costa and margin, many lying flat over the surface of the frond." The hairs which cover the nether surface of both species spring mostly from the margin, partly from the costa, none from the laminar surface. The best distinction is provided by the stellate hairs. The central stalk is commonly twice as long in *H. pilosissimum,* and the branches are much more numerous—rarely less than 4, rarely 7 or 8—and spreading in

all directions, instead of practically all ascending. It is the size of the hairs and the number of branches that make this much the more woolly species. The cell structure is identical, and so are the sori, except that here again *H. pilosissimum* is much more woolly.

Specimens: BORNEO, *Holttum, 25460, Clemens 28983* (both cited by Christensen). PHILIPPINES, *Elmer 6021, 9023, 9987, 10062, 13796, Merrill 6087, Bur. Sci. 9788, 15344, 23641, 28399, 30408, 37931, 40627, 41906.*

123. HYMENOPHYLLUM SUBOBTUSUM Rosenstock.

Hymenophyllum subobtusum ROSENSTORK, in Fedde's Repert. 9 (1910) 71.

Hymenophyllum; rhizomate filiformi, repente, ramoso, caespitoso, pilis longis, rufo-fuscis, pedicellato-stellatis hirsuto, folia subapproximata gerente; stipitibus 1–2 cm longis, teretibus, exalatis, stellato-pilosis; laminis ad 2–5 cm longis, 2 cm latis, e basi late cuneata linearibus vel oblongis. obtusis, nervis margineque exceptis glabris, subpinnatifidis; pinnis alternis, suberectis, medialibus maximis c. 1½ cm longis, ¾ cm latis, pinnulis 1–2 utrinque instructis, ceteris brevioribus, furcatis simplicibusve; pinnulis et laciniis c. 6 mm longis, 2 mm latis, linearibus, apicem versus paullo angustatis, obtusis, plerisque emarginatis, margine pilis rufo-fuscis, fasciatis, elongatis, apice furcatis vel stellatim radiatis dense vestitis; rhachibus subflexuosis, elastice curvatis, totis alatis, cum venis venulisque fusco-atris, uti margines frondis pilosis; soris apices laciniarum frondis superiores ac mediae terminantibus, e basi latissime cuneata subrotundis, latioribus quam longis; indusio mediotenus bivalvi, integerrimo, apice densissime hirsuto.

Nova Caledonia: In monte Tao, 800 m alt.; I. 1910, 1. *Franc. no 1421.*

Von dem ihr zunächststehenden *H. obtusum* Hk. et Arn. unterscheidet sich diese Art durch elastische Krümmung des Blattes, etwa doppelt so breite letzte Abschnitte, längere Stiele der Sternhaare und durch sternhaarige Bekleidung des Rhizoms.

So far as the limited material in the type collection shows, this is like *H. pilosissimum* in form of frond; more like *H. obtusum* in ascending branches of the hairs; different from both in having wider segments and longer hairs. The stalk cell of the marginal hair is about 0.5 mm long; the entire hair, more than 1 mm. The cellular structure is identical. Branched hairs on the lips of the involucre are commoner in this species.

Endemic in New Caledonia, and known by the type collection only.

124. HYMENOPHYLLUM OBTUSUM Hooker and Arnott.

Hymenophyllum obtusum HOOKER and ARNOTT, Bot. Voy. Beechey (1832) 109; HOOKER, Sp. Fil. 1: 93, *pl. 33, D.*

Frondibus caespitosis oblongis obtusissimis tripinnatifidis, laciniis (approximatis) linearibus erecto-patentibus, costa marginibusque pilis longis

stellatis obsitis, stipite gracillimo hirto, indusiis (in laciniis supremis) terminalibus orbicularibus pilis ramosis dense ciliatis.

This may be known from *H. hirsutum* by the longer branched or stellated hairs, which are confined wholly to the midrib and margin. The ultimate laciniae are somewhat corymbose, generally reaching to the same height, so as to give almost a truncated appearance to the outline of the frond.

(Sandwich Islands.)—HOOKER and ARNOTT, loc. cit.

Rhizome and stipe filiform, hairy with mostly simple but occasionally branched or stellate hairs; fronds up to 8 cm, but more commonly 3 to 4 cm long, the usual form, although the basic division is pinnate, being flabellate in appearance so that the fronds may be as broad as long, with a broad, rounded or truncate apex, the less common long forms (*Hildebrand*, collected in 1870, in Herb. Copeland, but not in U. S. Nat. Herb.; *Emma B. Freeman* in U. S. Nat. Herb.) lanceolate or oblanceolate, and pinnate in appearance as well as in fact; segments 5 to 8 mm long (less in small forms), about 1 mm wide, the margin and costa densely setose, the marginal hairs usually tufted, branched at the base only, or more generally consisting of a comparatively stout cell about $\frac{1}{6}$ mm long bearing two or three more slender suberect branches; cells large with very thin walls; sori terminal on the segments and mostly in the margin or broad apex of the frond as a whole, involucre about as wide as the segments, cleft to a very wide-angled base, setose on the lower part of the back, the lips densely ciliate with mostly solitary and simple hairs, receptacle short, globose.

Endemic in Hawaii, so far as my specimens show, and very commonly collected there. Distinguished from its local relative, *H. lanceolatum*, by denser pubescence with more spreading and branched hairs; usually, also, by the form of the frond.

125. **HYMENOPHYLLUM SPLENDIDUM** van den Bosch.

Hymenophyllum splendidum VAN DEN BOSCH, Ned. Kruid. Arch. 5[3] (1863) 192.

Hymenophyllum Plumieri KUHN, Fil. Afric. (1868) 41, *vix* HOOKER and GREVILLE.

Fronde lanceolata vel lineari-lanceolata elongata bipinnatifida, laciniis primariis patulis vel erecto-patulis remotis (imo distantibus) rhomboideo-oblongis, secundariis erectis (apice saepe recurvis) contiguis 1–2 furcatis vel simplicibus, lacinulis late linearibus modice elongatis planis, apice rotundato integro, margine minute denticulato, pilis stipitatis simplicibus furcatisve rigidis flavescenti-diaphanis, rhachi flexuosa debili setacea, pariter ac venae, angulo patente, venulaeque angulo acuto exeuntes, nigrescente dense hirsuta, cellulis diaphanis teneris mediocribus inaequalibus hexaëdris valde elongatis, parietibus hyalinis tenuibus minutissime denticulatis, interaneis amorphis parietalibus dilutiusculis flavescenti-fuscis,

medium oblongum hyalinum relinquentibus, marginalibus parvis angustis elongatis semihexaëdries, soris in lacinulis terminalibus immersis mediocribus, indusio basi late rotundato-conico, mediotenus bilobo, lobis semi-circularibus denticulatis ciliatis, receptaculo filiformi incluso, stipite apice alato setaceo flexuoso debili rufofusco hirsuto. Rhizoma repens ramosum setaceum pilosum, frons usque 4½ decim. longa, 5 centim. lata debilis (pendula) membranacea diaphana olivaceo-fusca.

Hab. Africa occidentalis (Ins. Fernando Po), MANN (H. HOOK.).

—VAN DEN BOSCH, loc. cit.

The Herbarium Lugduno-Batavum contains, besides the "authentic Specimen" of van den Bosch, which as usual is a fragment, a full sheet received later from Kew. The rachis is broadly winged; segments 1.3–2 mm wide, denticulate with minute, hair-bearing projections, and bearing similar hairs sparsely scattered over the laminar surface, the hairs minute, mostly once forked (with only two branches); sori narrower than the segments, about 1.5 mm long, with broadly cuneate to truncate, immersed base, and rounded lips, denticulate with projections bearing minute forked or simple hairs.

I have seen this from Fernando Po only; it is credited with a range on the African continent.

It seems to me very distinct from *H. ciliatum,* to which it has been reduced. In the presence of hairs on the laminar surface, it resembles rather the American (Jamaican) *H. hirsutum* (L.) Sw.

126. HYMENOPHYLLUM FERRUGINEUM Colla.

Hymenophyllum ferrugineum COLLA, Mém. Sci. Torino 39 (1836) 30.

Hymenophyllum subtilissimum KUNZE, Anal. Pterid. (1837) 49.

Hymenophyllum Frankliniae COLENSO, Tasm. Journ. 1 (1841) 378.

Hymenophyllum franklinianum COLENSO, Tasm. Journ. 2 (1844) 183.

Hymenophyllum aeruginosum β HOOKER, Sp. Fil. 1 (1844) 94 (and teste Syn. Fil. 64, pl. 34, A), *non* Carmichael.

"H. undique ferrugineo-pilosum, stipite rachideque teretibus, fronde pinnata, pinnis alternis ovatis pinnatisectis, segmentis 2–3-fidis simplicibusque, laciniis linearibus obtusis, soris terminalibus globosis." NOB. (Ad rupes et arborum radices in sylvis umbrosis montium editorum ins. *Iuan-Fernandez* Berter.).—COLLA, loc. cit.

The plant of Juan Fernandez is unknown to me, and its name for the New Zealand plant is accepted on faith.

Rhizome and stipe filiform, stipe 2 to 6 cm long, terete, dark, shining, naked in age except at the top; frond 10 to 18 cm long, lanceolate, tripinnatifid, rachis terete in the lower part, winged above, everywhere densely beset with solitary or clustered stel-

late hairs, segments 2 to 3 mm long, 0.6 to 1 mm wide, ciliate with clustered stellate hairs with four to six branches from stouter stalk-cells, the laminar surface also bearing some similar but solitary hairs; cells mostly isodiametric, small, walls thin and undifferentiated; sori as wide as the segments, and, except for the hairs, shorter than wide, involucre cleft to the immersed broadly cuneate or rounded base, lips long-ciliate with branched and stellate hairs, receptacle included, columnar.

Specimen: NEW ZEALAND, *Kirk 261, 803, Ranft, Cunningham, Petrie, Bell, Smith.* STRAITS OF MAGELLAN, *Safford 368,* bears no hairs on the lamina.

9. Subgenus APTEROPTERIS nomen novum

Lamina vera omnino carente, filamentis brevibus cellularum axibus frondis ubique excurrentibus pilis stellatis dense obtectis substituta, segmentis frondis deinde crasse filiformibus haud applanatis.

A single species, related to *Sphaerocionium* as shown by the stellate pubescence, endemic in New Zealand.

127. HYMENOPHYLLUM MALINGII (Hooker) Mettenius.

Hymenophyllum Malingii (Hooker) METTENIUS, Hymen. (1864) 423, *pl. 1, fig. 32* (*non rite*); GIESENHAGEN, Flora (1890) 448, *pl. 4, fig. 25.*

Trichomanes Malingii HOOKER, Garden Ferns (1862) *pl. 64.*

Caudex long, slender, filiform; stipites scattered on the caudex rarely more than an inch long, slender; fronds two to four inches long, oblong-lanceolate, tri-quadripinnate, or rather perhaps pinnatifid, destitute of any wing or foliaceous portion, consisting of rachis alone; the ultimate branches are often forked, and in the fertile fronds almost all the branches are soriferous at the apex, and the whole frond is clothed with a dense stellated pubescence of a ferruginous colour on one side and a pale grey on the other; involucres terminal, subhemispherical, of a thick and firm texture, obscurely two-lipped, and with the lips lobed; column scarcely exerted, thick, fleshy, fusiform.

Hab. *Mr. Maling,* it appears, is the fortunate discoverer of this remarkable hymenophyllaceous Fern on the ranges of Golden Bar, Middle Island, New Zealand, and *Mr. Brunner,* Surveyor General, Middle Island, on the "mountain-range between Blind Bay and Massacre Bay" (possibly the same locality).—HOOKER, loc. cit.

Mettenius, loc. cit., says "*H. Malingii* . . . bietet das einzige Beispiel unter den Hymenophyllaceen und Farnen überhaupt, wo alle und jede Spur einer blattartigen Ausbildung fehlt." Giesenhagen recognized the presence of parenchyma cells, each growing out into a "papilla." It is the multitude of these papillæ, standing closely side by side, and completely sheathing

the axes, which takes the place, physiologically, of the lamina; the layer of papillæ is protected in turn by interwoven horizontal branches of the stellate hairs, the stalk cells of which run out between the papillæ from the sclerenchyma sheaths of the bundles; sori on the apices of any or all segments, slightly wider than the segments but very small, about 1 mm long, the apex with two very short, broad lips, the entire involucre immersed in the stellate pubescence borne on every part of it; receptacle cylindric, usually a little longer than the involucre.

Specimens: NEW ZEALAND, *Kirk, Cheeseman, Sledge 120, Brame, Thomson, Ranft-Rosenstock, Fil. Novae Zeal. n. 9, Petrie.* TASMANIA, *Rodney.*

Without evident near relatives.

SPECIES ERRATIM SUB HYMENOPHYLLO DESCRIPTAE

HYMENOPHYLLUM?

Hymenophyllum Foxworthyi COPELAND, Philip. Journ. Sci. § C 12 (1917) 45 = *Trichomanes pallidum* Bl. broadly construed; more exactly *Craspedoneuron Braunii* van den Bosch.

Hymenophyllum Rolandi Principis ROSENSTOCK, Fedde's Repert. 9 (1910) 72.

This plant, "Hymenophyllum (ex opinione)" of Rosenstock, and easily recognized as "einen isolierten Typ," cannot, in my opinion, whatever its fructification, be included in the genus. It does appear to belong in the family. As between the two old genera, I would rather guess it to be *Trichomanes,* but regard it rather as a distinct genus—if it belongs in the family at all.

It was collected sterile on Mount Tao, altitude 700 m, by *Franc* in 1910, and is otherwise unknown. No specimen is in the Bonati Herbarium, but the Univ. Calif. Herb. contains an excellent specimen, sterile of course, from Rosenstock, ex Herb. Bonaparte.

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ILLUSTRATIONS

[Drawings of Meringium are mostly by E. Borbe; of Mecodium by L. Alicbusan. Photographs by the Bureau of Science.]

PLATE 1

Hymenophyllum ricciaefolium Bory. *Herb. Lugd.-Bat. 908, 282–729,* from Bourbon; *1,* frond, × 0.5; *2,* cells, × 380; *3,* sorus, × 30.

PLATE 2

Hymenophyllum pollenianum Rosenstock. Type, in Herb. Lugd.-Bat.; *1,* frond, × 1.5; *2,* cells, × 380; *3,* sorus, × 30; *4,* receptacle, × 30.

PLATE 3

Hymenophyllum macroglossum van den Bosch. Cotype, in Gray Herb.; *1,* frond, × 1.5; *2,* cells, × 380; *3,* sorus, × 30; *4,* receptacle, × 30.

PLATE 4

Hymenophyllum penangianum Matthew and Christ. Illustrated by the type of *H. semifissum,* in Phil. Nat. Herb.; *1,* frond, × 2.5; *2,* cells, × 380; *3,* sorus, × 30.

PLATE 5

Hymenophyllum pachydermicum Cesati. Figs. 1 to 3, *Clemens 28270,* in Phil. Nat. Herb.; *1,* frond, × 1; *2,* dorsal surface of pinnæ, × 1.3; *3,* sorus, × 20; *4, Clemens 22173,* cells, × 250; *5,* cells of type (Beccari), × 250; figs. 6 to 8, type of *H. Clemensiae; 6,* frond, × 1.6; *7,* sorus, × 20; *8,* receptacle (broken), × 20; *9,* type of *H. halconense,* cells, × 250.

PLATE 6

Hymenophyllum pulchrum Copeland sp. nov. Type, in Phil. Nat. Herb.; *1,* frond, × 0.5; *2,* cells, × 380; *3,* sorus, × 30.

PLATE 7

Hymenophyllum edentulum Christensen. *1,* Type fragment in Herb. Lugd.-Bat., cells, × 380; figs. 2 to 3, *Bur. Sci. 78730* in Herb. Copeland; *2,* frond, × 1.5; *3,* sorus, × 15.

PLATE 8

Hymenophyllum Meyenianum Copeland. *1,* Frond, cotype of *H. serrulatum* in Phil. Nat. Herb. × 0.3; *2,* cotype of same in Gray Herb., cells, × 250; figs. 3 to 6, cells, × 250; *3, Bur. Sci. 29701,* from Rizal; *4, Weber 1448,* from Davao; *5, Elmer 9910,* from Negros; *6, Bur. Sci. 33305,* from Ilocos Norte; figs. 7 and 8, sori, × 10; *7,* cotype in Phil. Nat. Herb.; *8, Yates s. n.,* from Mount Banahao.

PLATE 9

Hymenophyllum vittatum Copeland sp. nov. Type, *1*, frond, × 1; *2*, cells, × 380; *3*, sorus, × 15.
Hymenophyllum Ramosii Copeland sp. nov. Type, *4*, frond, × 1; *5*, cells, × 380; *6*, sorus, × 15.

PLATE 10

Hymenophyllum bicolanum Copeland sp. nov. Type in Phil. Nat. Herb. *1*, frond, × 2; *2*, cells, × 380; *3*, sorus, × 30.

PLATE 11

Hymenophyllum campanulatum Christ. Cotype in Phil. Nat. Herb.; *1*, frond, × 2; *2*, cells, × 380; *3*, sorus, × 30.

PLATE 12

Hymenophyllum bontocense Copeland sp. nov. Type; *1*, frond, × 1; *2*, cells, × 380; *3*, sorus, × 15; *4*, three sori on one plant, × 5.

PLATE 13

Hymenophyllum Merrillii Christ. Cotype in Phil. Nat. Herb.; *1*, frond, × 1.5; *2*, cells, × 380; *3* and *4*, sori, × 30.

PLATE 14

Hymenophyllum holochilum (van den Bosch) Christensen. *1*, Type in Herb. Lugd.-Bat., cells, × 250; *2*, *Bakh van den Brink 5878* in Herb. Univ. Calif., frond, × 1; *3*, sorus of same, × 20; *4*, sorus of type, × 20.

PLATE 15

Hymenophyllum denticulatum Swartz. Figs. 1 to 5, *Mousset*, in Phil. Nat. Herb.; *1*, frond, × 1; *2*, detail of margin, × 52; *3*, cells, × 350; *4*, sorus, × 10; *5*, sporangium, × 52; *6*, *Bur. Sci. 17524*, tip of frond, × 3; *7* and *8*, *Palmer and Bryant 577*, in Herb. Univ. Calif., sorus, ventral and dorsal faces, × 10.

PLATE 16

Hymenophyllum Hosei Copeland. Cotype in Herb. Copeland; *1*, frond, × 1.5; *2*, cells, × 380; *3* and *4*, sorus, both sides, × 30; *5*, sporangium, × 78.

PLATE 17

Hymenophyllum acanthoides (van den Bosch) Rosenstock. Sumatra specimen in Herb. Lugd.-Bat.; *1*, frond, × 1; *2*, cells, × 380; *3*, sorus, × 15; *4*, receptacle, × 30.

PLATE 18

Hymenophyllum blandum Raciborski. Figs. 1 to 3, *Elmer 11690*, in Phil. Nat. Herb.; *1*, frond, × 2.5; *2*, cells, × 380; *3*, sorus, × 30; *4*, sorus of cotype, × 30.

PLATE 19

Hymenophyllum johorense Holttum. Type, in Herb. Singap.; *1*, frond, × 3.3; *2*, cells, × 250; *3*, hair, × 250; *4*, sorus, × 20; *5*, sporangium, × 52.

PLATE 20

Hymenophyllum reductum Copeland sp. nov. Type; *1*, frond, × 3; *2*, cells, × 380; *3*, marginal hair, × 78; *4*, sorus, × 15.

PLATE 21

Hymenophyllum Rosenstockii Brause. Cotype, ex Mus. Bot. Berol.; *1*, frond, × 2; *2*, cells, × 380.
Hymenophyllum herterianum Brause. Type fragment, ex Mus. Bot. Berol.; *3*, cells, × 380.

PLATE 22

Hymenophyllum ovatum Copeland. Type, in Herb. Copeland; *1*, frond, × 2; *2*, cells, × 380; *3*, sorus, × 30; *4*, sporangium, × 78.

PLATE 23

Hymenophyllum Foersteri Rosenstock. Cotype, in Herb. Univ. Calif.; *1*, frond, × 1; *2*, cells, × 380; *3*, marginal tooth, × 78; *4*, sorus, × 15; *5*, receptacle, × 15.

PLATE 24

Hymenophyllum viride Rosenstock. Type, in Herb. Lugd.-Bat.; *1*, frond, × 1.5; *2*, cells, × 380; *3*, sorus, × 30.

PLATE 25

Hymenophyllum Macgillivrayi (Baker) Copeland. *Horne*, in Gray Herb.; *1*, frond, × 1.5; *2*, cells, × 380; *3*, sorus, × 30.

PLATE 26

Hymenophyllum gorgoneum Copeland sp. nov. Type, in Phil. Nat. Herb.; *1*, frond, × 1.5; *2*, cells, × 380; *3*, sorus, × 15.

PLATE 27

Hymenophyllum feejeense Brackenridge. Type, in U. S. Nat. Herb.; *1*, frond, × 1; *2*, cells, × 380; *3*, sorus, × 30.

PLATE 28

Hymenophyllum praetervisum Christ. *Reinecke 88*, in U. S. Nat. Herb.; *1*, frond, × 1.5; *2*, cells, × 380; *3*, sorus, × 15.

PLATE 29

Hymenophyllum Armstrongii Kirk. *Kirk, 138*; *1*, frond, × 5; *2*, cells, × 380; *3*, sorus, old, × 30; *4*, sorus, young, in outline, × 30; *5*, sporangium, × 78.

PLATE 30

Hymenophyllum multifidum **Swartz.** ***Ranft,*** **in Herb. Univ. Calif.;** *1,* **frond (very large),** × **0.5;** ***2,*** **cells,** × 380; ***3,*** **sorus,** × **15.**

Hymenophyllum bivalve Swartz. *Holloway* specimen, in Herb. Univ. Calif.; *4,* pinna, × 1; *5,* sorus, × 15; *6,* cells, × 380.

PLATE 31

Hymenophyllum fuscum van den Bosch. *Copeland,* Mount Gedeh; *1,* photograph, showing fronds of typical *H. fuscum* and approximately typical *H. Zollingerianum* on the same rhizome, × 0.3; *2,* cells, × 250; *3,* sorus, × 20; *4,* sporangium, × 52.

PLATE 32

Hymenophyllum Ledermannii Brause. Cotype, from Mus. Bot. Berol.; *1,* pinna, × 3.3; *2,* cells, × 250; *3,* sorus, × 20.

PLATE 33

Hymenophyllum geluense Rosenstock. *Bamler,* in Herb. Univ. Calif.; *1,* frond, × 0.6; *2,* cells, × 250; *3,* sorus, × 20; *4,* sporangium, × 52.

PLATE 34

Hymenophyllum laminatum Copeland. Type, in Herb. Copeland; *1,* frond, × 0.6; *2,* cross section, × 20; *3,* cells, × 250; *4,* sorus, × 20; *5,* sporangium, × 52.

PLATE 35

Hymenophyllum odontophyllum Copeland sp. nov. Type; *1,* frond, × 1; *2,* detail of rachis, × 10; *3,* detail of pinnule, × 10; *4,* sorus, × 15; *5,* cells, × 380.

PLATE 36

Hymenophyllum Baileyanum Domin. Type collection, ex Queensland Herb.; *1,* frond, × 0.6; *2* and *3,* cells, × 250; *4,* sorus, × 10.

Hymenophyllum Deplanchei Mettenius. Topotype, in Herb. Univ. Calif.; *5,* frond, × 0.6; *6,* cells, × 250; *7,* sorus, × 10.

PLATE 37

Hymenophyllum peltatum Desvaux. *Perrier de la Bathie 13758,* in U. S. Nat. Herb.; *1,* frond, × 2; *2,* cells, × 380; *3,* sorus, × 30.

PLATE 38

Hymenophyllum affine Brackenridge. Type; *1,* frond, × 2.5; *2,* cells, × 380; *3,* sorus, × 30; *4, Parks 20040,* frond, × 2.

PLATE 39

Hymenophyllum perfissum Copeland. Cotype, in Herb. Copeland; *1,* frond, × 2; *2,* cells, × 380; *3,* sorus, × 30; *4,* sporangium, × 78.

PLATE 40

Hymenophyllum antarcticum Presl. Cotype, in Herb. Lugd.-Bat.; *1*, frond, × 1.5; *2*, cells, × 380; *3*, sorus, × 30.

PLATE 41

Hymenophyllum Cheesemanii Baker. Probable cotype; *1*, frond, × 5; *2*, cells, × 380; *3*, sorus, × 30.

PLATE 42

Hymenophyllum tunbridgense (L.) Smith. Topotype, *U. S. Nat. Herb. 57545; 1*, frond, × 1.6; *2*, cells, × 250; *3*, sorus, × 20; figs. 4 to 6, *H. dregeanum*, cotype, in Herb. Lugd.-Bat.; *4*, frond, × 1; *5*, cells, × 250; *6*, sorus, × 20.

PLATE 43

Hymenophyllum barbatum (van den Bosch) Baker. Type collection in Herb. Lugd.-Bat.; *1*, frond, × 2.5; *2*, cells, × 250; *3*, sorus, × 20; *4*, *Hancock 206*, in U. S. Nat. Herb., frond, × 1.

PLATE 44

Hymenophyllum simonsianum Hooker. *Henderson*, in U. S. Nat. Herb.; *1*, frond, × 1.5; *2*, cells, × 380; *3*, sorus, × 15.

PLATE 45

Hymenophyllum pumilum C. Moore. *Moore*, in U. S. Nat. Herb.; *1*, frond, × 1.5; *2*, cells, × 380; *3*, sorus, × 15.

Hymenophyllum Pumilio Rosenstock. Cotype; *4*, frond, with sorus, × 15; *5*, cells, × 190.

PLATE 46

Hymenophyllum polyanthos Swartz. Figs. 1 to 4, "*H. subdemissum* Christ," topotype, *Elmer 18014; 1*, frond, × 1; *2*, cells, × 250; *3*, sorus, × 20; *4*, receptacle, × 20; *5* to *13*, sori, all × 20; *5*, *6*, and *6a*, *Bur. Sci. 77215*, from same frond; *7*, *Bur. Sci. 43006*, "*pseudorarum;*" *8*, *Merrill 6948; 9*, *Bur. Sci. 83462; 10* and *11*, *Clemens 27027* (*H. microchilum*); *12*, *Clemens 40984; 13*, *Bur. Sci. 77216*.

PLATE 47

Hymenophyllum polyanthos Swartz. (Figs. 1 to 5, *H. gracilius* cotype, Herb. Univ. Calif.); *1* and *2*, fronds, × 0.5; *3*, cells, × 250; *4*, sorus, × 20; *5*, receptacle, × 20; *6*, lax frond, *Bur. Sci. 14845*, × 0.5; *7*, congested frond, *Bur. Sci. 16661*, × 1; figs. 8 to 10, "*H. punctisorum;*" *8*, sorus, × 20; *9*, receptacle, × 20; *10*, cells, × 250.

PLATE 48

Hymenophyllum Kuhnii Christensen. *Daubenberger*, in Herb. Univ. Calif.; *1*, frond, × 0.5; *2*, cells, × 380; *3*, sorus, × 30; *4*, receptacle, × 30.

PLATE 49

Hymenophyllum recurvum Gaudichaud. Cotype, in Phil. Nat. Herb.; *1*, frond, × 0.6; *2*, cells, × 250; *3*, sorus, × 20; *4*, receptacle, × 20.

PLATE 50

Hymenophyllum angulosum Christ. Cotype, in Phil. Nat. Herb.; *1*, frond, × 0.5; *2*, cells, × 380; *3*, sorus, × 15; *4*, receptacle, × 30.

PLATE 51

Hymenophyllum paniculiflorum Presl. Cotype, in Phil. Nat. Herb.; *1*, frond, × 1; *2*, cells, × 380; *3*, sorus, × 30; *4*, receptacle, × 30; *5*, Mindanao specimen, *Bur. Sci. 38565*, cells, × 380.

PLATE 52

Hymenophyllum nitiduloides Copeland sp. nov. Type; *1*, frond, × 2; *2*, cells, × 380; *3*, sorus, × 30; *4*, receptacle, × 30.

PLATE 53

Hymenophyllum sanguinolentum Swartz. *Cheeseman*, in Herb. Univ. Calif.; *1*, frond, × 0.5; *Brame*, in U. S. Nat. Herb.; *2*, cells, × 380; *3*, sorus, × 15; *4*, sorus with cristate back, × 15; *5*, receptacle, × 30.

PLATE 54

Hymenophyllum productum Kunze. *Hort. Bog. 273, Herb. Lugd.-Bat. 90, 281–549; 1*, frond, × 0.5; *2*, cells, × 380; *3*, sorus, × 15; *4*, receptacle, × 30.

PLATE 55

Hymenophyllum Reinwardtii van den Bosch. Type, in Herb. Lugd.-Bat.; *1*, frond, × 0.5; *2*, cells, × 78; *3*, cells, × 380; *4*, sorus, × 15; *5*, receptacle, × 30.

PLATE 56

Hymenophyllum thuidium Harrington. Cotype, in U. S. Nat. Herb.; *1*, frond, × 0.3; *2*, portion of frond, × 20; *3*, cells, × 52; *4*, cells, × 250; *5*, sorus, × 10; *6*, receptacle, × 20.

PLATE 57

Hymenophyllum samoense Baker. *Gillespie 5125*, from Fiji, in Herb. Univ. Calif.; *1*, frond, × 0.5; *2*, detail of margin, × 78; *3*, cells, × 380; *4*, sorus, × 15; *5*, receptacle, × 30.

PLATE 58

Hymenophyllum emarginatum Swartz. Type, in Herb. Swartz, Stockholm; *1*, cells, × 250; *2*, sorus, × 10; *3*, receptacle, × 20; figs. 4 to 8, "*H. eximium,*" *Zollinger 258*, in Herb. Lugd.-Bat.; *4*, frond, × 0.3; *5*, cells, × 250; *6*, sorus, × 10; *7* and *8*, receptacles, × 20; figs. 9 to 11, "*H. modestum;*" *9*, sorus of type, × 20; *10*, cells of type, × 250; *11*, receptacle of cotype, in Phil. Nat. Herb., × 20.

PLATE 59

Hymenophyllum javanicum Sprengel. Figs. 1 to 4, *Palmer and Bryant 753*, from Java; *1*, frond, × 0.6; *2*, cells, × 250; *3*, sorus, × 10; *4*, receptacle, × 20; *5*, *Palmer and Bryant 851*, sorus, × 10; *6*, *Palmer and Bryant 360*, sorus, × 10; *7*, *Yates 2863*, sorus, × 10; *8*, *Yates 2698*, sorus, × 10; *9*, *Gillespie 3823*, from Fiji, sorus, × 10; all in Herb. Univ. Calif.

PLATE 60

Hymenophyllum fimbriatum J. Smith. Figs. 1 to 4, cotype, in Phil. Nat. Herb.; *1*, frond, × 0.5; *2*, cells, × 380; *3*, sorus, × 15; *4*, receptacle (of small sorus), × 30; figs. 5 to 8, involucres, × 15; *5*, *Bur. Sci. 42225*, from Rizal; *6*, *Bur. Sci. 75698*, from Albay; *7*, *Yoder s. n.*, from Panay; *8*, cotype of *H. fraternum*, from Panay.

PLATE 61

Hymenophyllum riukiuense Christ. *Faurie 4640*, in Herb. Copeland; *1*, frond, × 1; *2*, cells, × 380; *3*, sorus, dissected, × 30; *4*, receptacle, × 30.

PLATE 62

Hymenophyllum flabellatum La Billardière. *Kerschner*, U. S. Nat. Herb.; *1*, frond, × 0.5; *2*, cells, × 380; *3*, sorus, × 15; *4*, receptacle, × 30; *5*, hair of rhizome, × 40.

PLATE 63

Hymenophyllum Le Ratii Rosenstock. *Fil. Nov. Caled. Exsic. 64*, in Phil. Nat. Herb.; *1* and *2*, fronds, × 0.6; *3*, cells, × 250; *4*, sorus, × 20; *5*, receptacle, × 20; *6*, sporangia.

PLATE 64

Hymenophyllum rarum R. Brown. Fig. 1, *Cheeseman*, in Herb. Univ. Calif.; *1*, frond, × 1.5; figs. 2 to 5, *Ranft*, in Herb. Univ. Calif.; *2*, frond, × 0.5; *3*, cells, × 380; *4*, sorus, × 15; *5*, receptacle, × 15.

PLATE 65

Hymenophyllum involucratum Copeland. Type collection; *1*, frond, × 1.3; *2*, cells, × 250; *3*, sorus, × 20; *4*, receptacle, × 20.

PLATE 66

Hymenophyllum Walleri Maiden and Betche. Type, in Queensland Herb.; *1*, frond, × 2; *2*, cells, × 380; *3*, sorus, × 15; *4*, receptacle, × 30.

PLATE 67

Hymenophyllum mnioides Baker. *Franc*, in Herb. Univ. Calif.; *1*, frond, × 3; *2*, cells, × 380; *3*, sorus, × 15; *4*, receptacle, × 30.

PLATE 68

Hymenophyllum montanum Kirk. Probable cotype, in U. S. Nat. Herb.; *1*, frond, × 1.5; *2*, cells, × 380; *3*, sorus, × 30; *4*, receptacle, × 30.

PLATE 69

Hymenophyllum fumarioides Baker. *Wright,* in Herb. Lugd.-Bat.; *1,* frond, × 1; *2,* cells, × 250; *3,* sorus, × 10; *4,* receptacle, × 20; *5* and *6,* "*H. parvum,*" *Perrier 18377,* in U. S. Nat. Herb., fronds, × 3.

PLATE 70

Hymenophyllum imbricatum Blume. *1* and *2,* "*H. bamlerianum,*" cotype, *Bamler S 50,* sorus and receptacle, × 20; *3* and *4,* *Bamler 50,* sorus and receptacle, × 20; figs. 5 to 9, "*H. imbricatum*" in Herb. Lugd.-Bat.; *5* to *8,* receptacles, × 20; *9,* sporangium, × 52.

PLATE 71

Hymenophyllum imbricatum Blume. "*H. formosum,*" type, *1,* frond, × 0.3; *2,* cells, × 250; *3,* sorus, × 20; *4,* receptacle, × 20; *5,* sporangium, × 52; *6* to *8,* receptacles, × 20.

PLATE 72

Hymenophyllum Treubii Raciborski. *Raciborski,* in Phil. Nat. Herb.; *1,* frond, × 1; *2,* cells, × 250; *3,* sorus, × 20; *4,* receptacle, × 20.

PLATE 73

Hymenophyllum Junghuhnii van den Bosch. Eligible type; *1,* small frond, × 0.3; *2,* cells, × 250; *3,* sorus, × 20; *4,* receptacle, × 20; *5* and *6,* receptacles of Javan specimens, × 20; *7,* sporangium, × 52.

PLATE 74

Hymenophyllum longifolium v. A. van Rosenburgh. *Brass 1467,* in Herb. Copeland; *1,* frond, × 0.3; *2,* cells, × 250; *3,* sorus, × 20; *4,* receptacle, × 20.

PLATE 75

Hymenophyllum salakense Raciborski. Figs. 1 and 2, *Raciborski,* in Phil. Nat. Herb.; *1,* frond, × 0.3; *2,* cells, × 250; *3,* topotype, *Bakh van den Brink,* in Herb. Univ. Calif., sorus, × 20; *4,* receptacle, × 20.

PLATE 76

Hymenophyllum badium Hooker and Greville. Figs. 1 to 4, *Cuming 130,* cotype of *Sphaerocionium macrocarpum,* in Phil. Nat. Herb.; *1,* frond, × 0.3; *2,* cells, × 250; *3,* sorus, × 20; *4,* receptacle, × 20; *5,* mature, and *5a,* young, receptacles, *Bur. Sci. 3548,* from the Batanes; *6,* *Bur. Sci. 8383,* near Manila; *7* to *9,* *Pételot 3905,* from Tonkin.

PLATE 77

Hymenophyllum crispatum Wallich. *Bur. Sci. 5443 Ramos,* in Phil. Nat. Herb.; *1,* frond, × 0.5; *2,* cells, × 380; *3,* sorus, × 15; *4,* receptacle, × 30.

PLATE 78

Hymenophyllum crispatum, illustrated by typical *H. pleiocarpum*, *Bünnemeyer 9245*, in Herb. Lugd.-Bat.; *1*, frond, × 0.5; *2*, cells, × 380; *3*, sorus, × 15; *4*, receptacle, × 30.

PLATE 79

Hymenophyllum crispato-alatum Hayata. *Faurie 627*, in Phil. Nat. Herb.; *1*, frond, × 0.5; *2*, cells, × 380; *3*, sorus, × 30; *4*, receptacle, × 30.

PLATE 80

Hymenophyllum flexile Makino. *Tagawa 242*, in Phil. Nat. Herb.; *1*, frond, × 0.3; *2*, cells, × 250; *3*, sorus, × 20; *4*, receptacle, × 20.

PLATE 81

Hymenophyllum opacum Copeland sp. nov. Type; *1*, frond, × 0.3; *2*, cells, × 250; *3*, sorus, × 20; *4*, receptacle, × 20.

PLATE 82

Hymenophyllum Wrightii van den Bosch. Figs. 1 to 3, cotype, in U. S. Nat. Herb.; *1*, frond, × 3; *2*, cells, × 380; *3*, sorus, × 30; figs. *4* and *5*, *Taquet*, in Herb. Copeland; *4*, fronds, × 1.5; *5*, receptacle, × 30.

PLATE 83

Hymenophyllum exsertum Wallich. *Mann*, in U. S. Nat. Herb.; *1*, frond, × 0.5; *2*, cells, × 380; *3*, sorus, × 30; *4*, receptacle, × 30.

PLATE 84

Hymenophyllum flexuosum A. Cunn. *Setchell*, in Herb. Univ. Calif.; *1*, frond, × 0.5; *2*, cells, × 380; *3*, sorus, × 30; *4*, receptacle, × 30.

PLATE 85

Hymenophyllum australe Willdenow. *Gunn*, in U. S. Nat. Herb.; *1*, frond, × 0.5; *2*, cells, × 380; *3*, sorus, × 30; *4*, receptacle, × 30.

PLATE 86

Hymenophyllum demissum Swartz. Figs. 1, 2, 4, and 9, *Brame*, in U. S. Nat. Herb.; fig. 3, *Kirk*. *1*, Frond, × 0.3; *2* and *3*, pinnæ, × 0.3; *4*, cells, showing double margin, × 250; *5*, sorus, × 10; *6*, receptacle, × 20; *7* to *10*, double sori, × 20.

PLATE 87

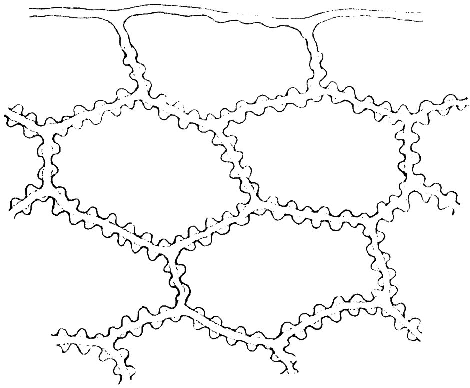
Hymenophyllum dilatatum Swartz. Figs. 1 to 3 and 5 to 8, *Setchell*, Herb. Univ. Calif.; *1*, frond, × 0.3; *2*, cells, × 250; *3*, cells, surface layer in solid lines, middle layer in broken lines, bottom layer in dotted lines, × 50; *4*, section, by van den Bosch, × 35; *5*, sorus, × 20; figs. 6 to 9, receptacles, × 20; *9*, from *Brackenridge* specimen, in U. S. Nat. Herb.

PLATE 88

Hymenophyllum scabrum A. Richard. *Cheeseman*, in U. S. Nat. Herb.; *1*, frond, × 0.5; *2*, hairs, at base of stipe, × 15; *3*, sorus, × 30; *4*, receptacle, × 20; *5*, drawing by van den Bosch, in Herb. Lugd.-Bat., of cross section of lamina, × 65.

PLATE 89

Hymenophyllum marginatum Hooker and Greville. *Watts*, in U. S. Nat. Herb.; *1*, frond, × 4.5; *2*, cells, × 380; *3*, sorus, × 30; *4*, receptacle, × 30.



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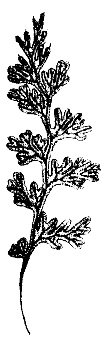

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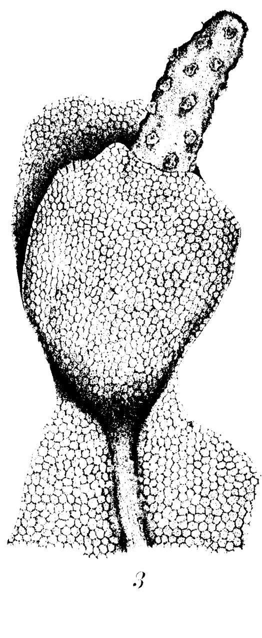

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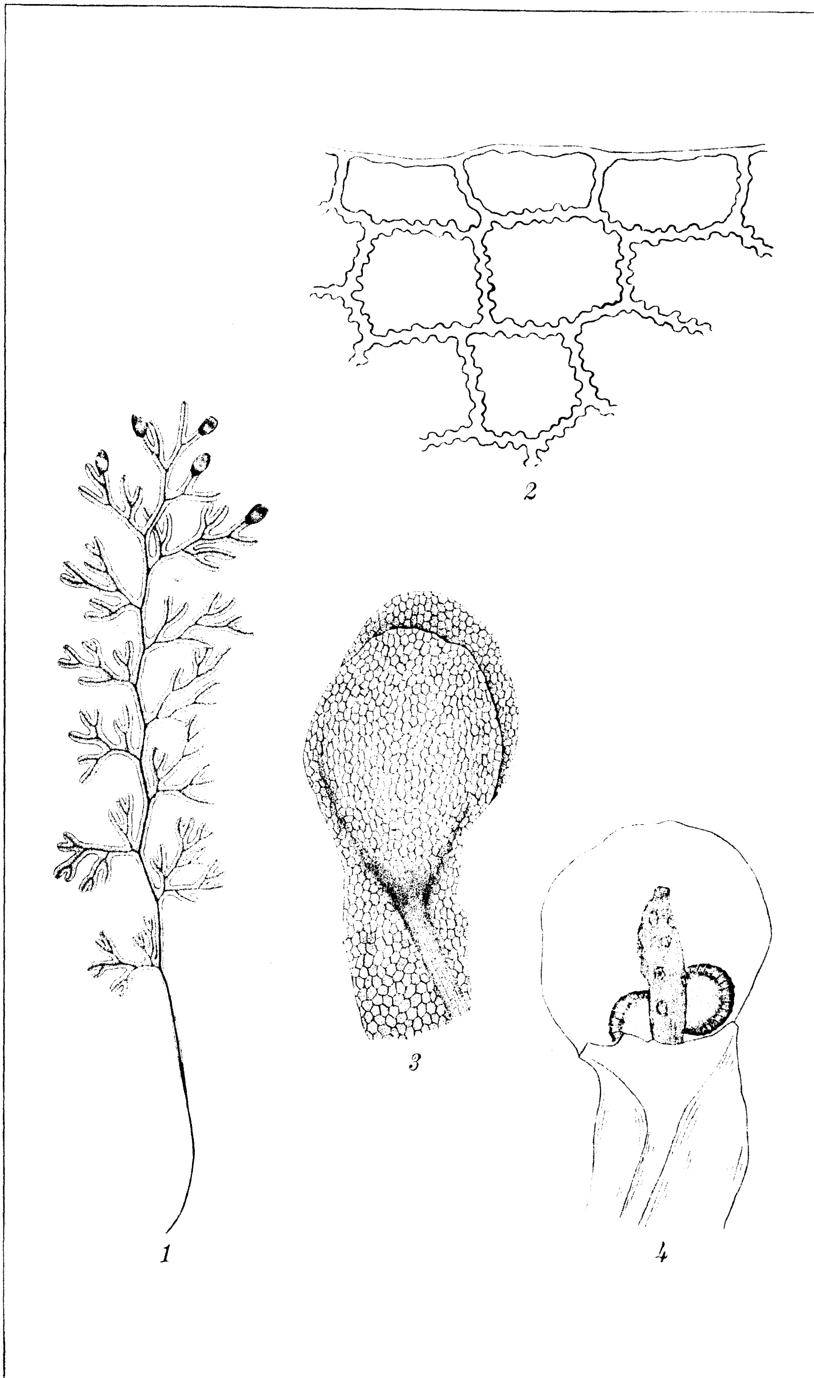

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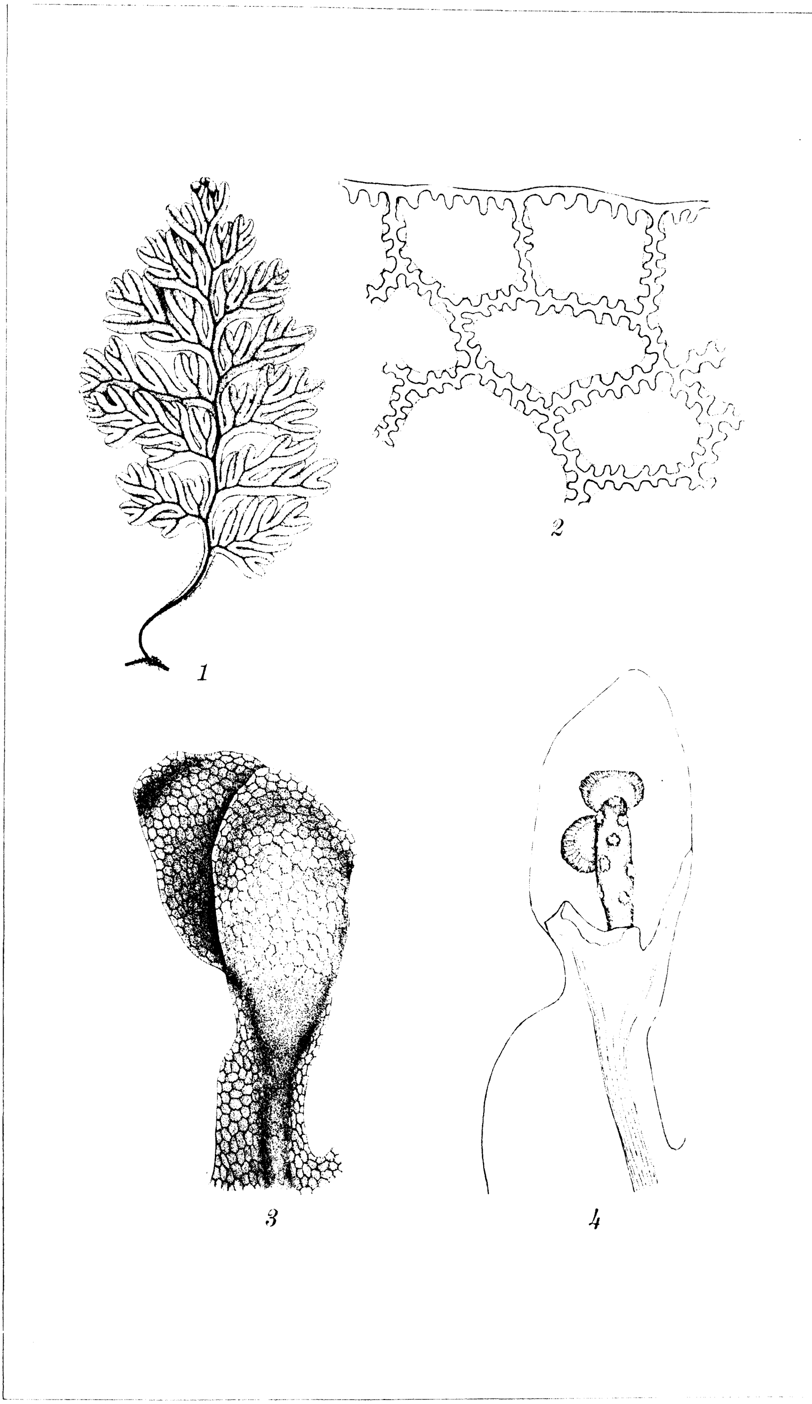

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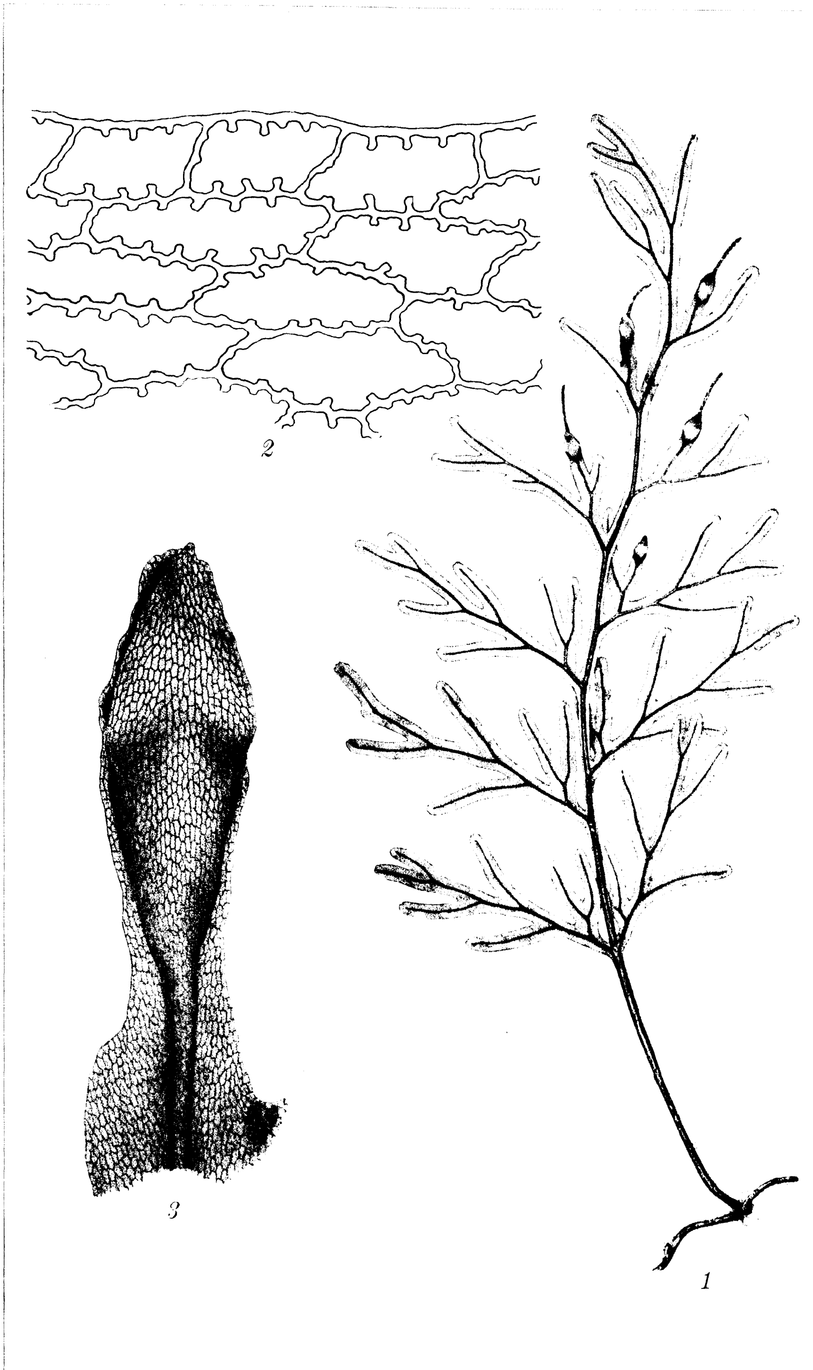

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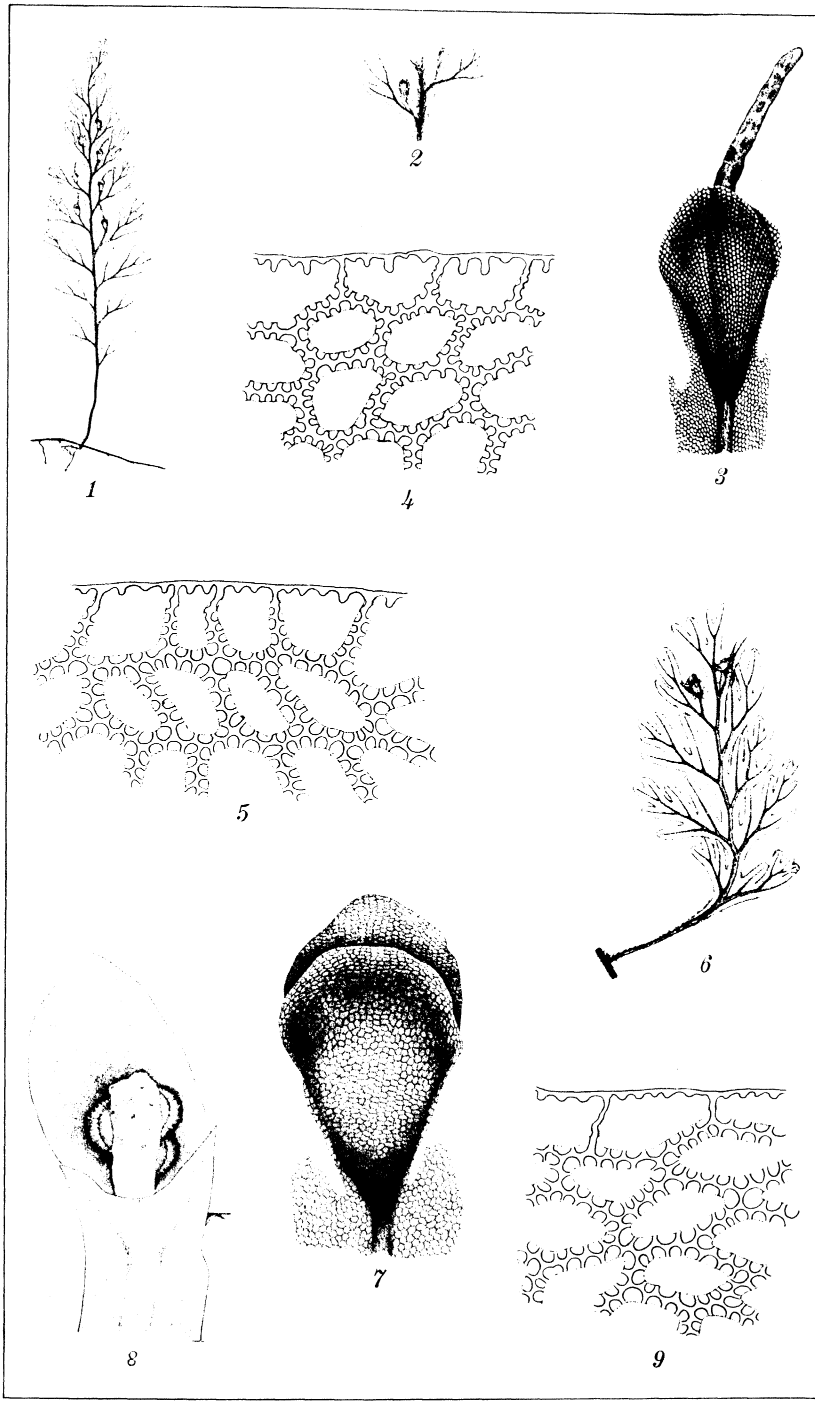

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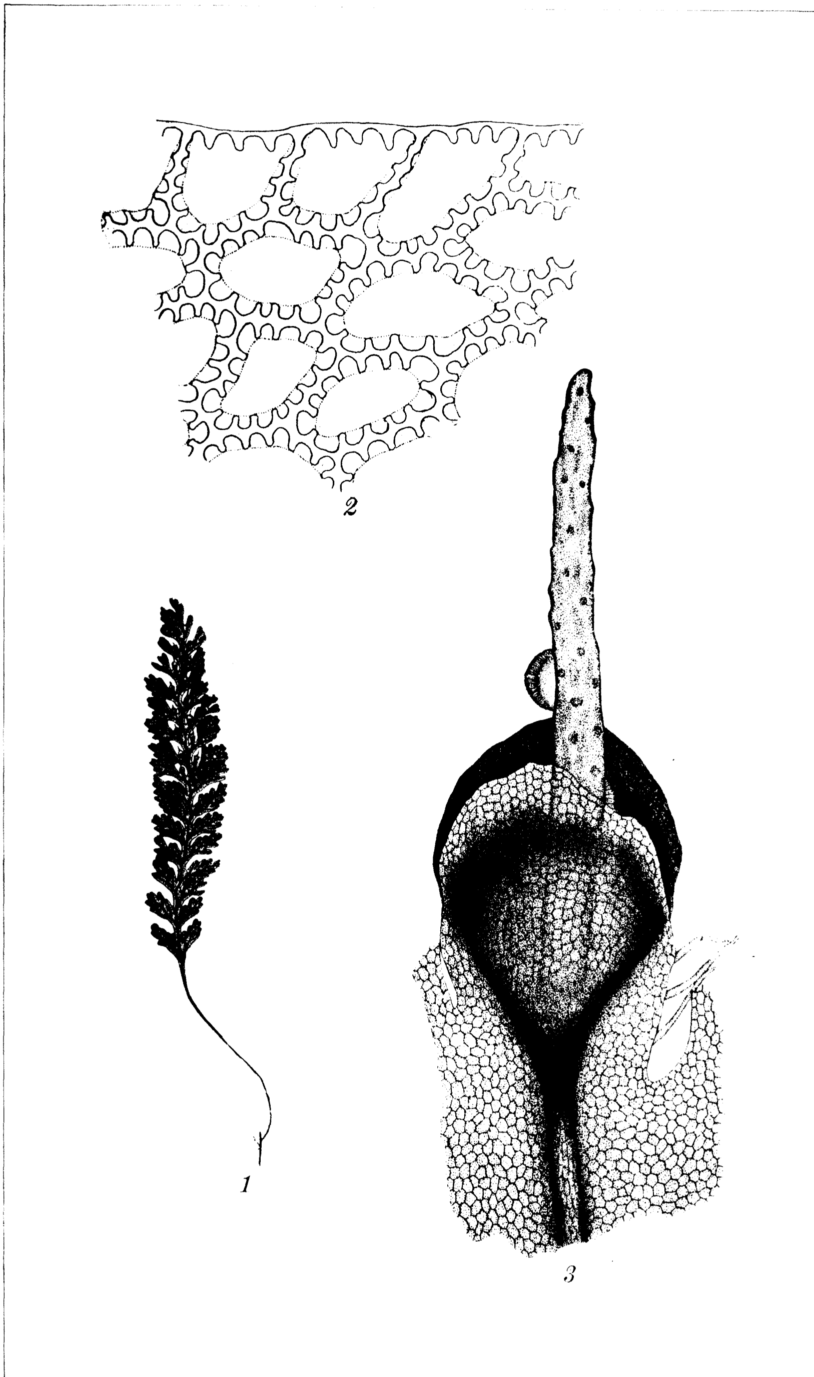

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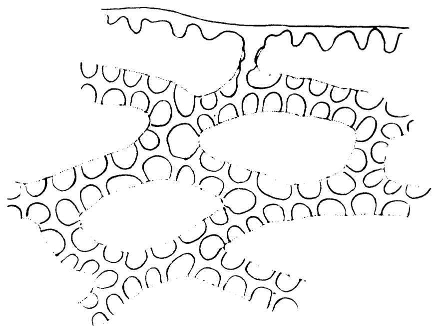

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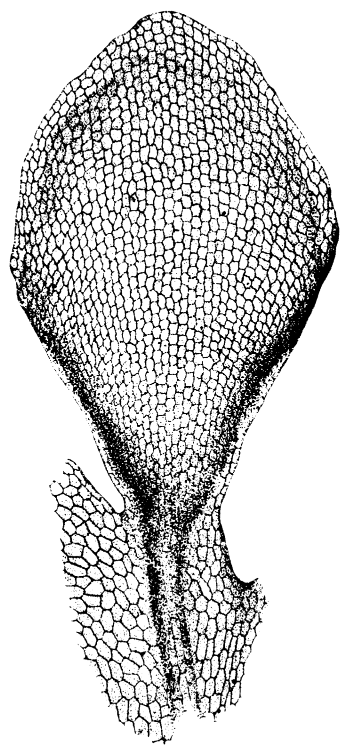

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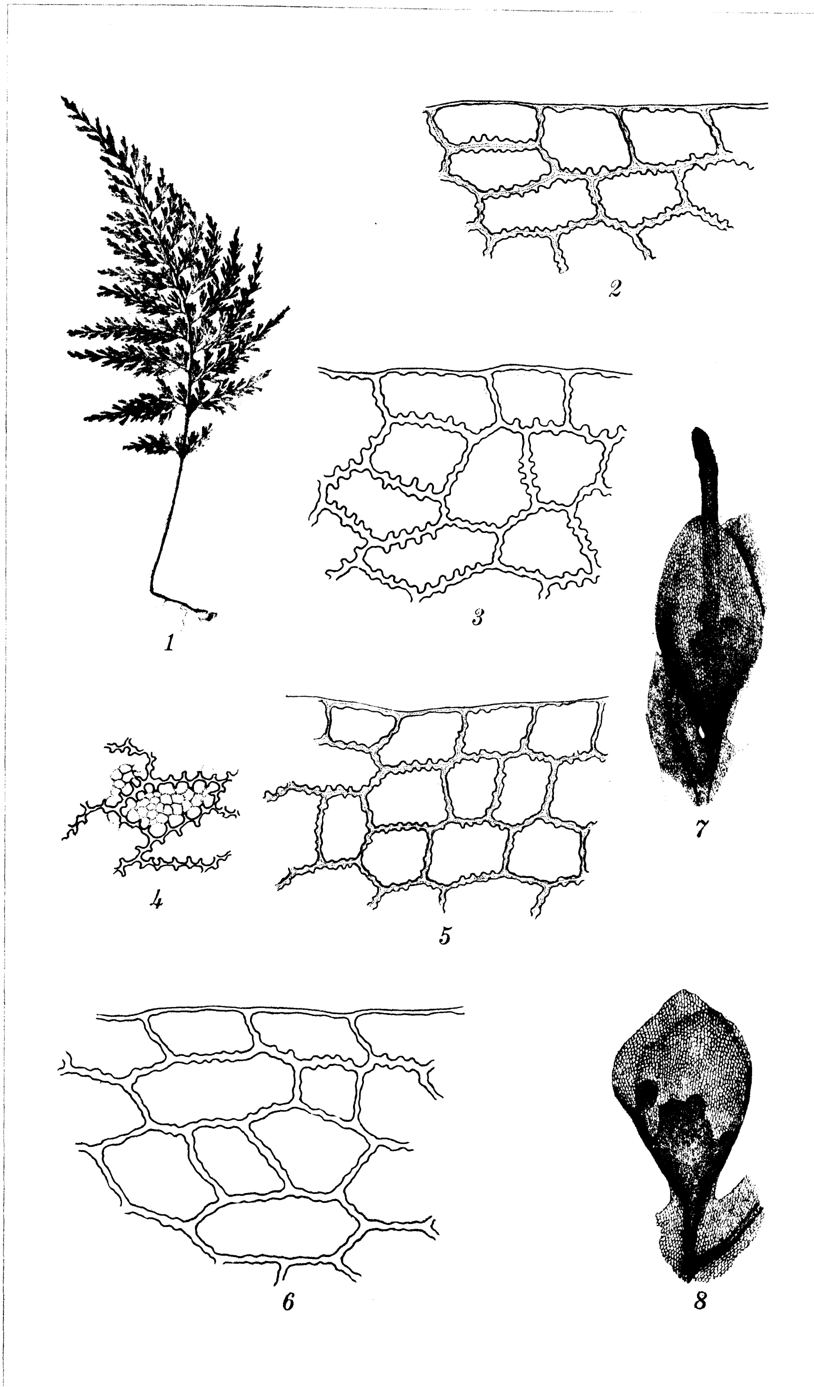

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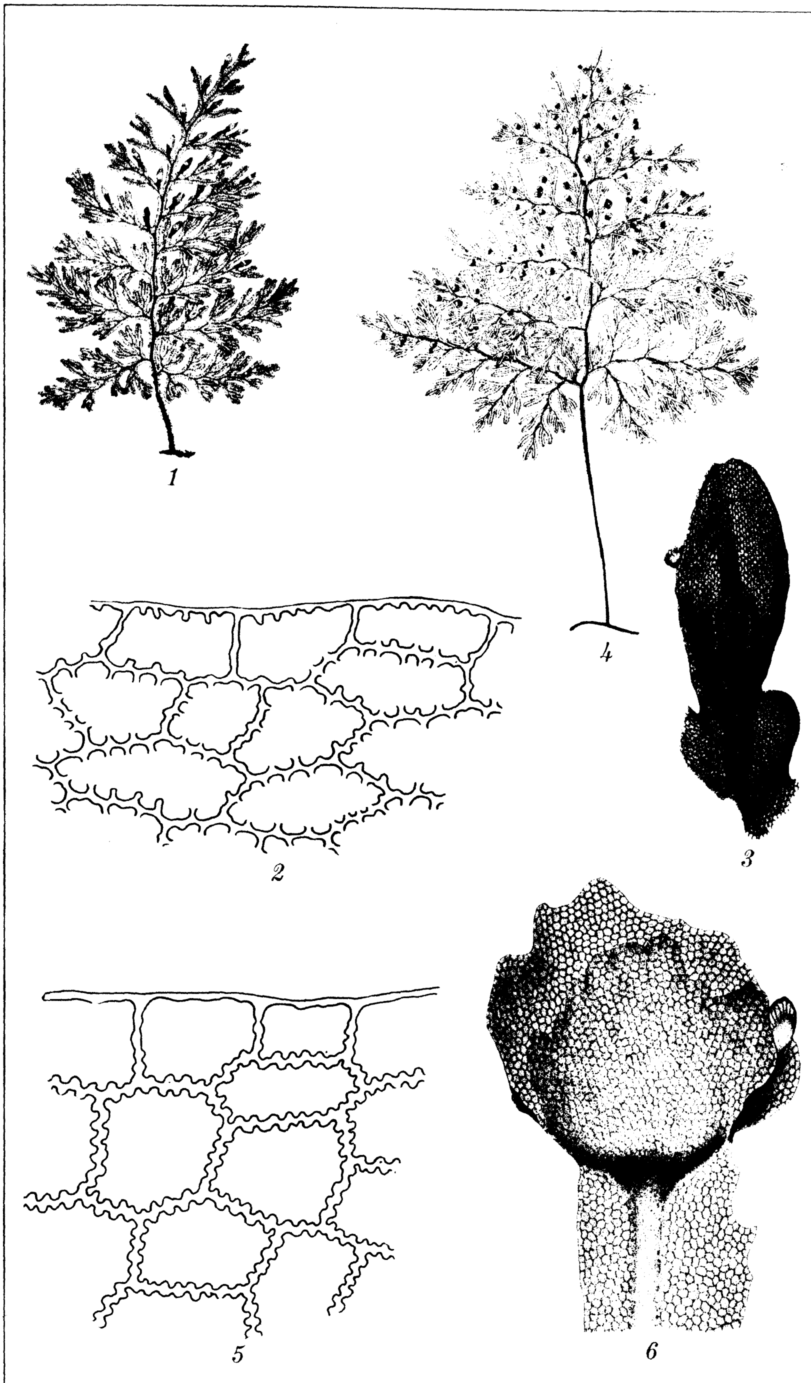

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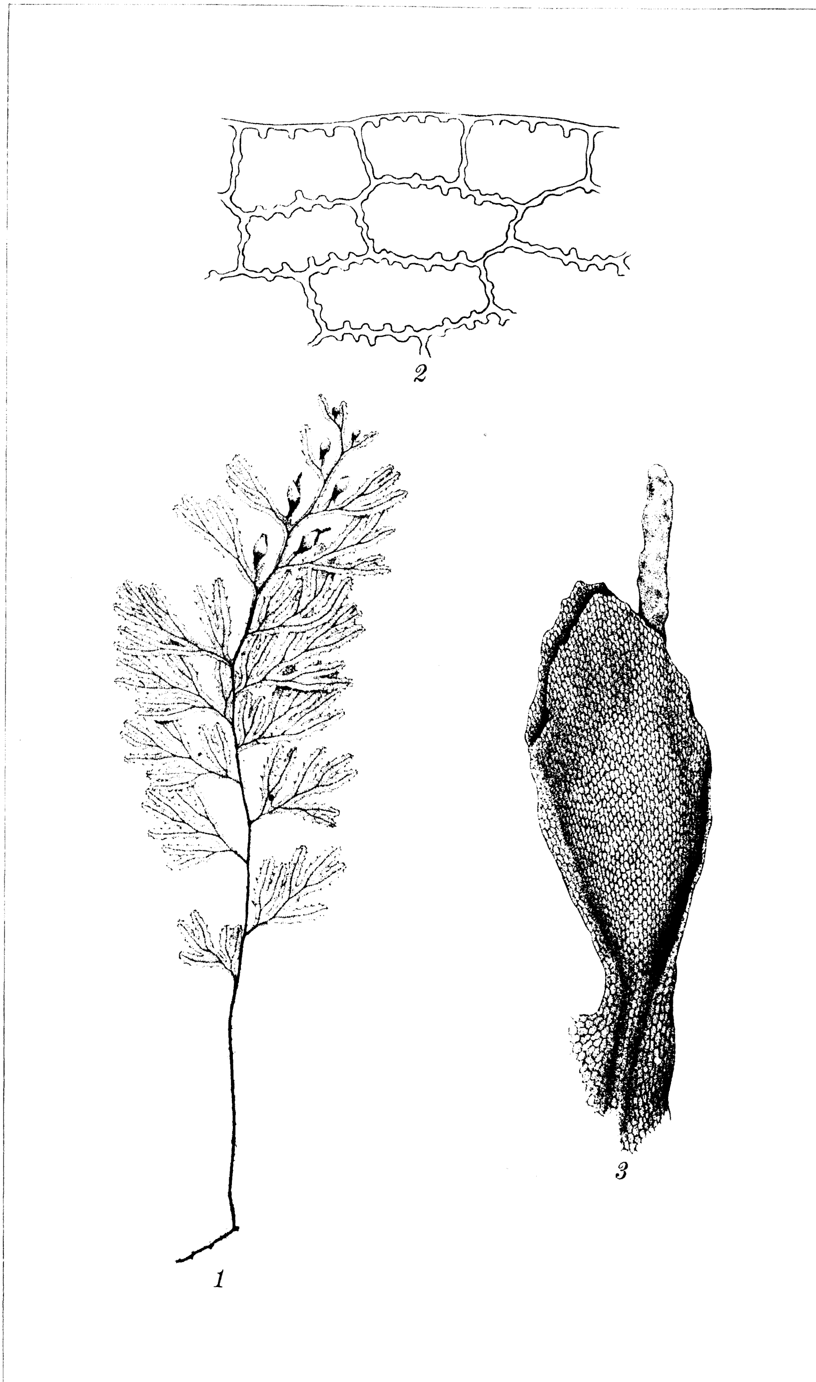

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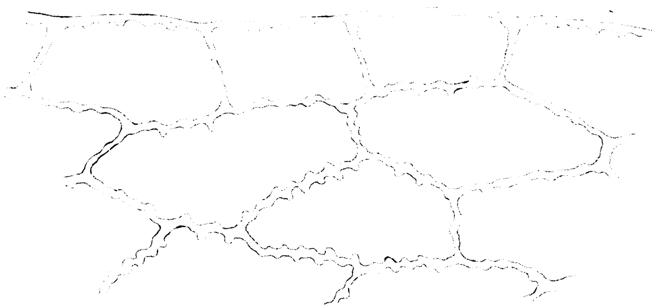

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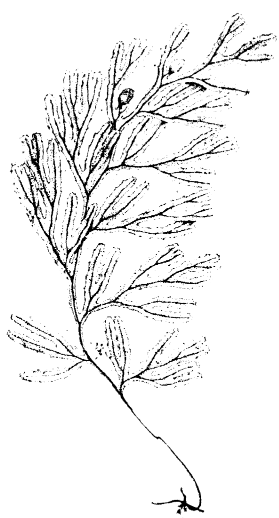

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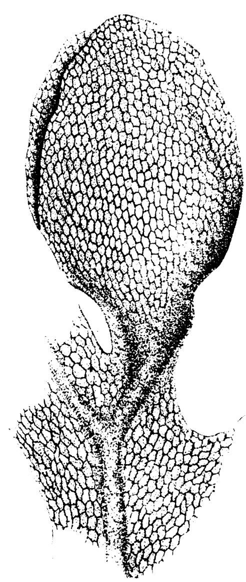

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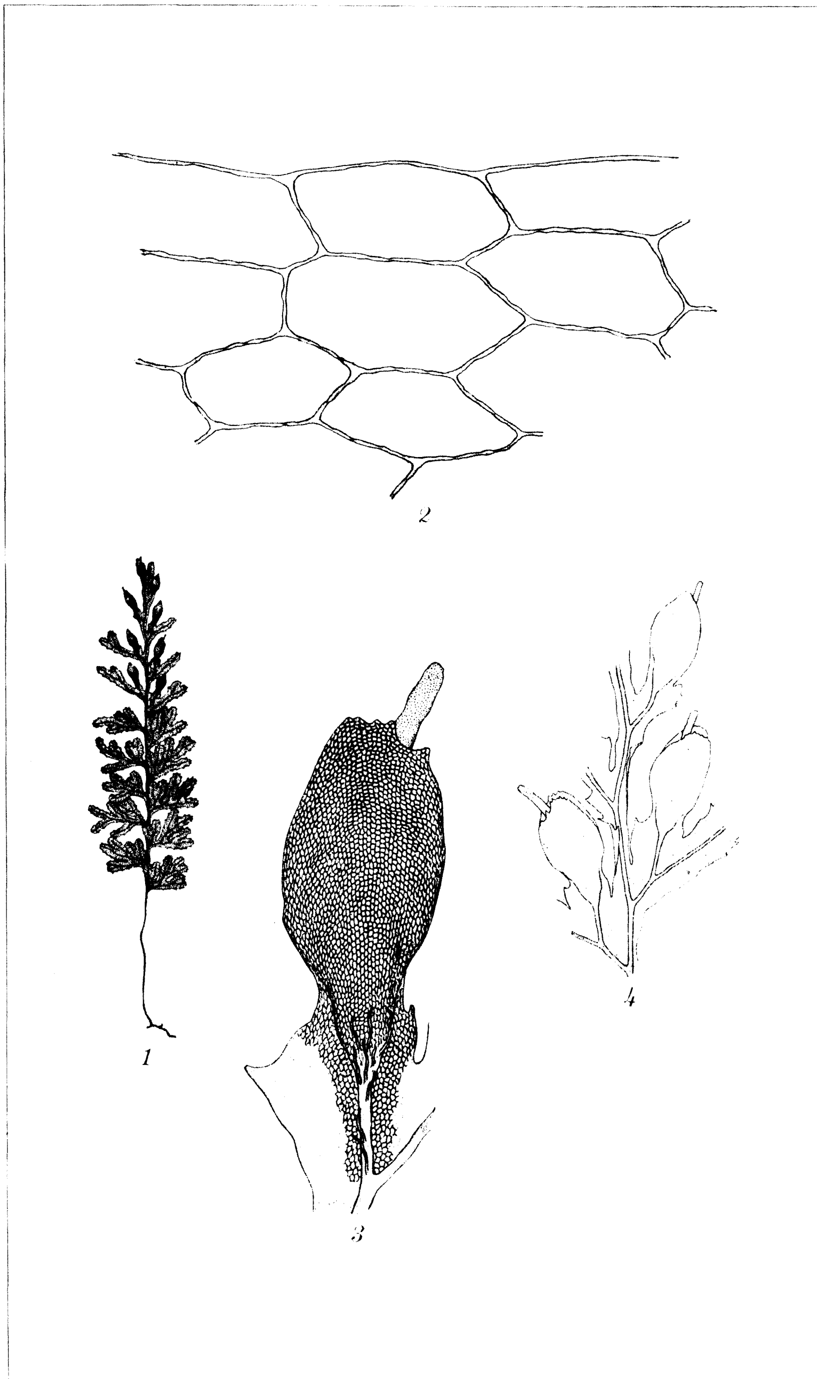

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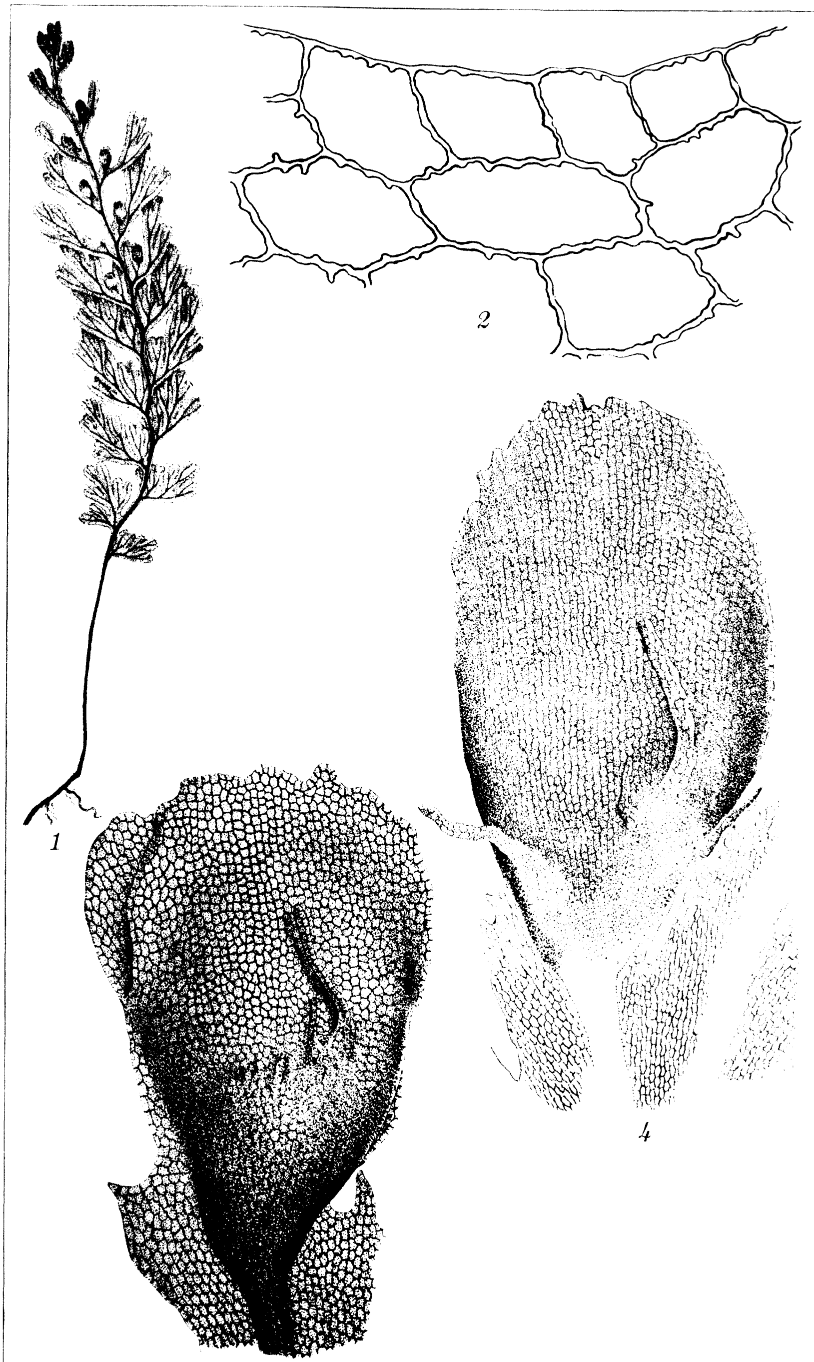

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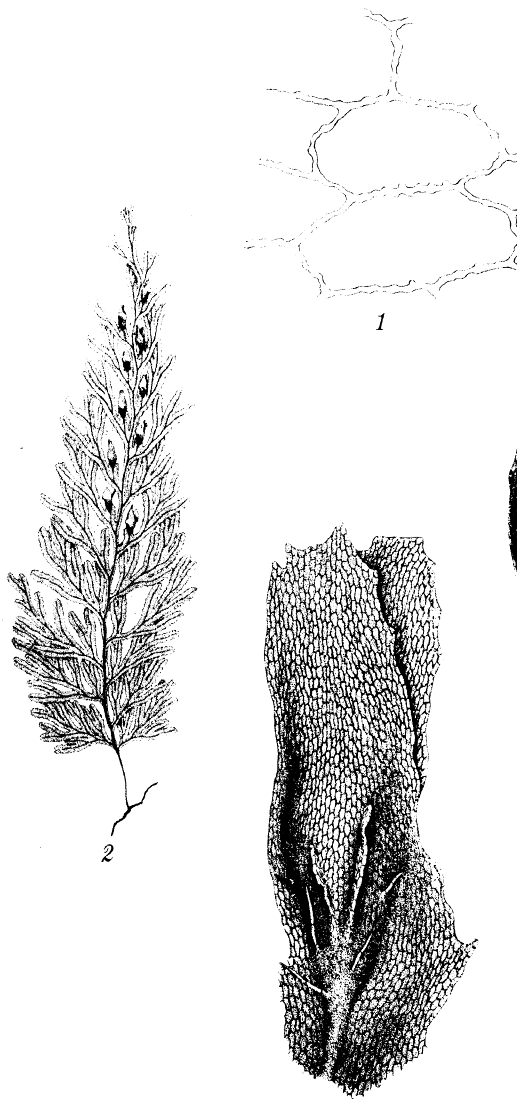

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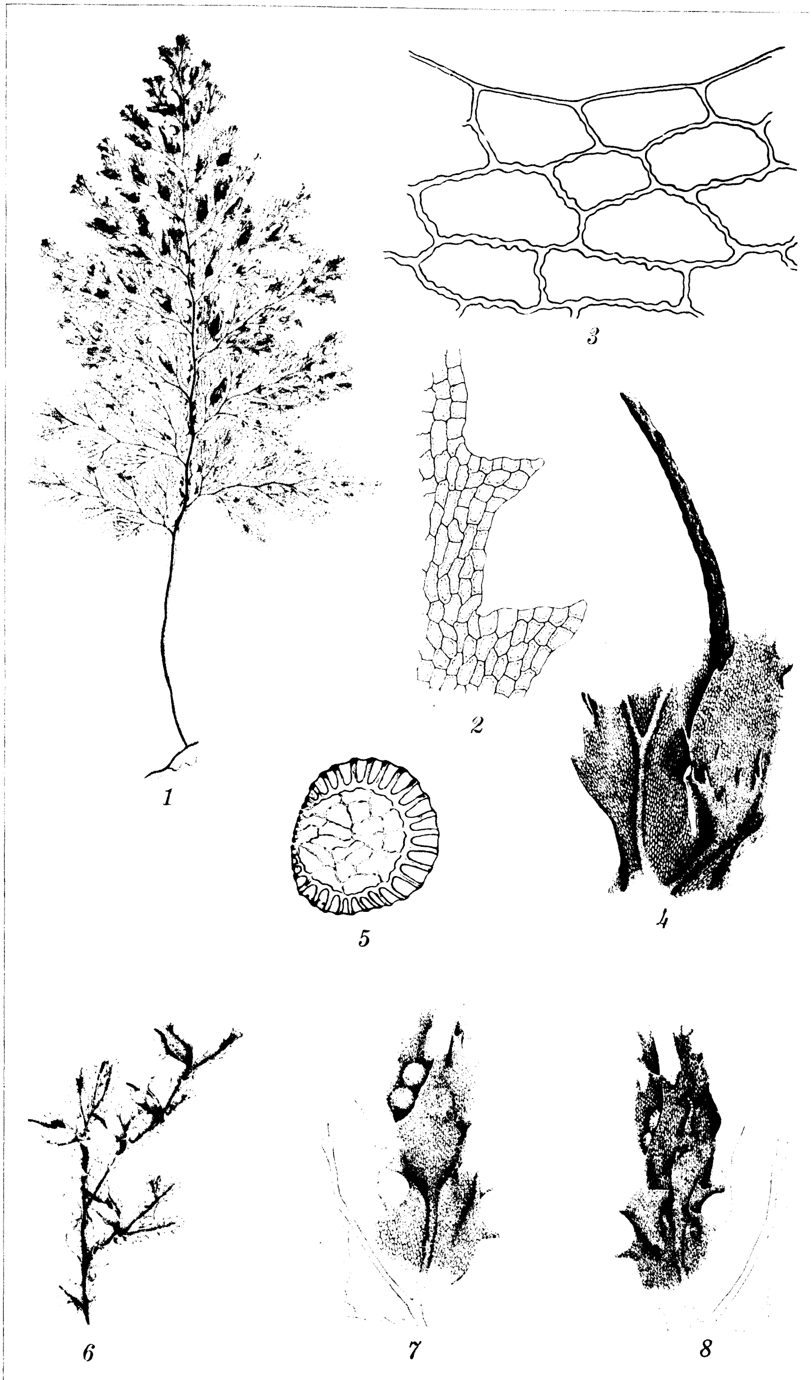

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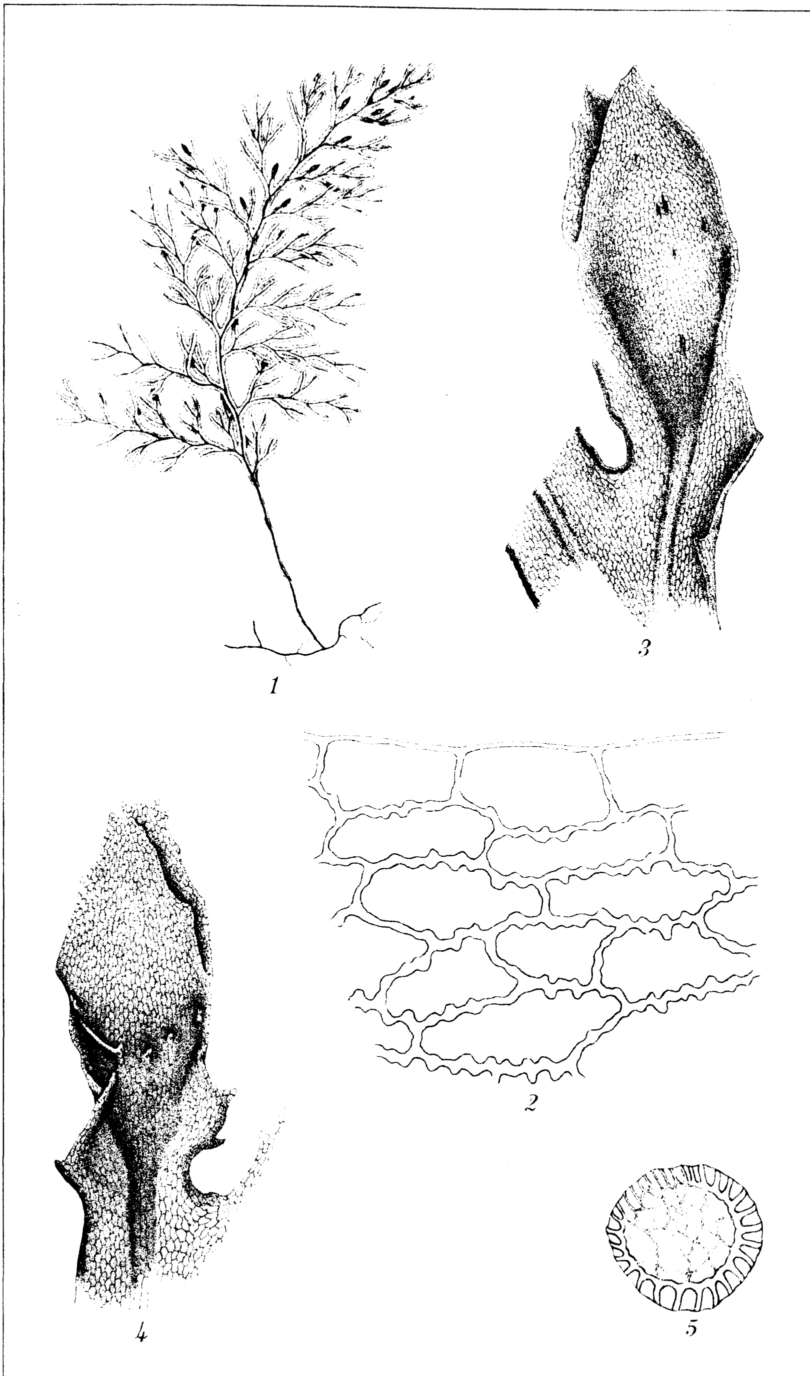

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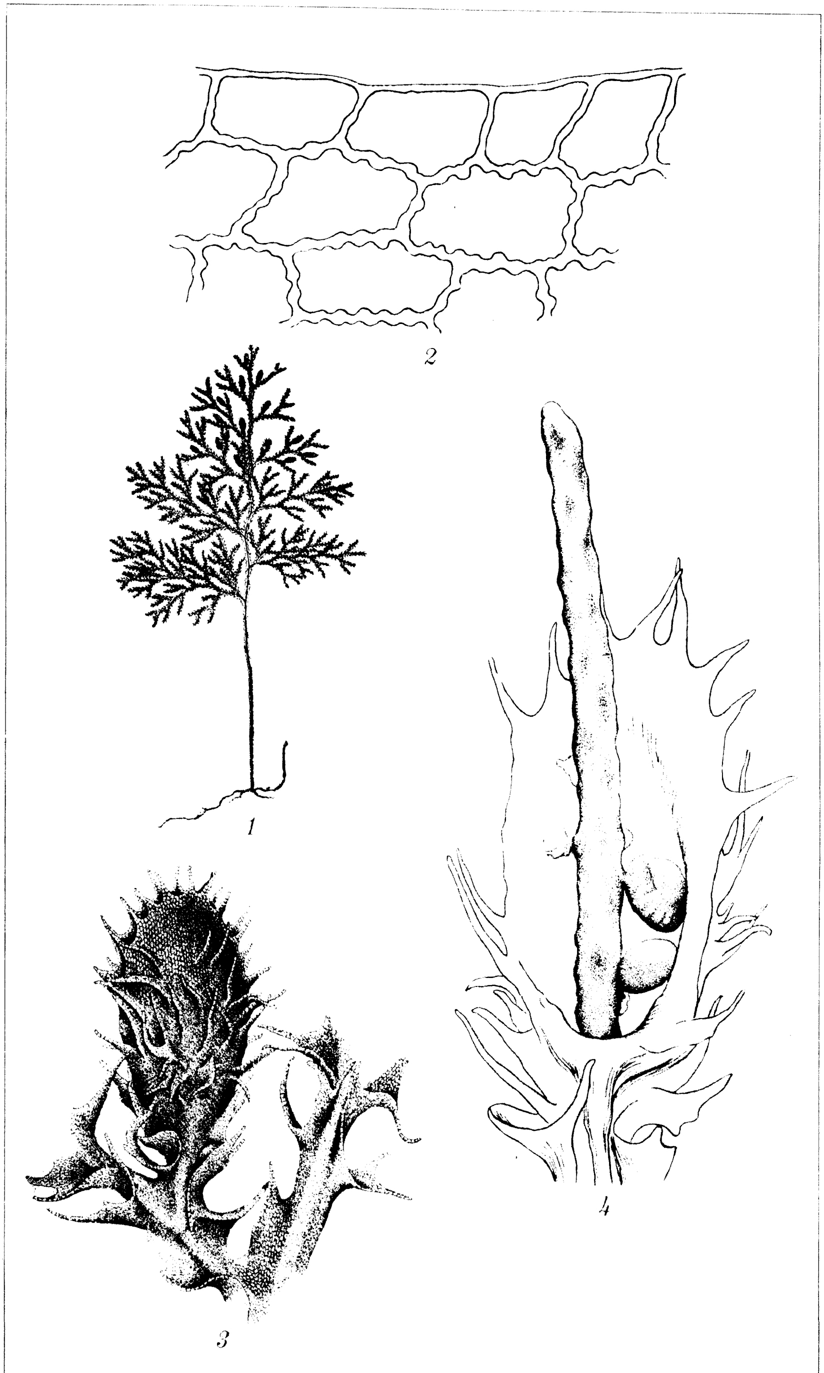

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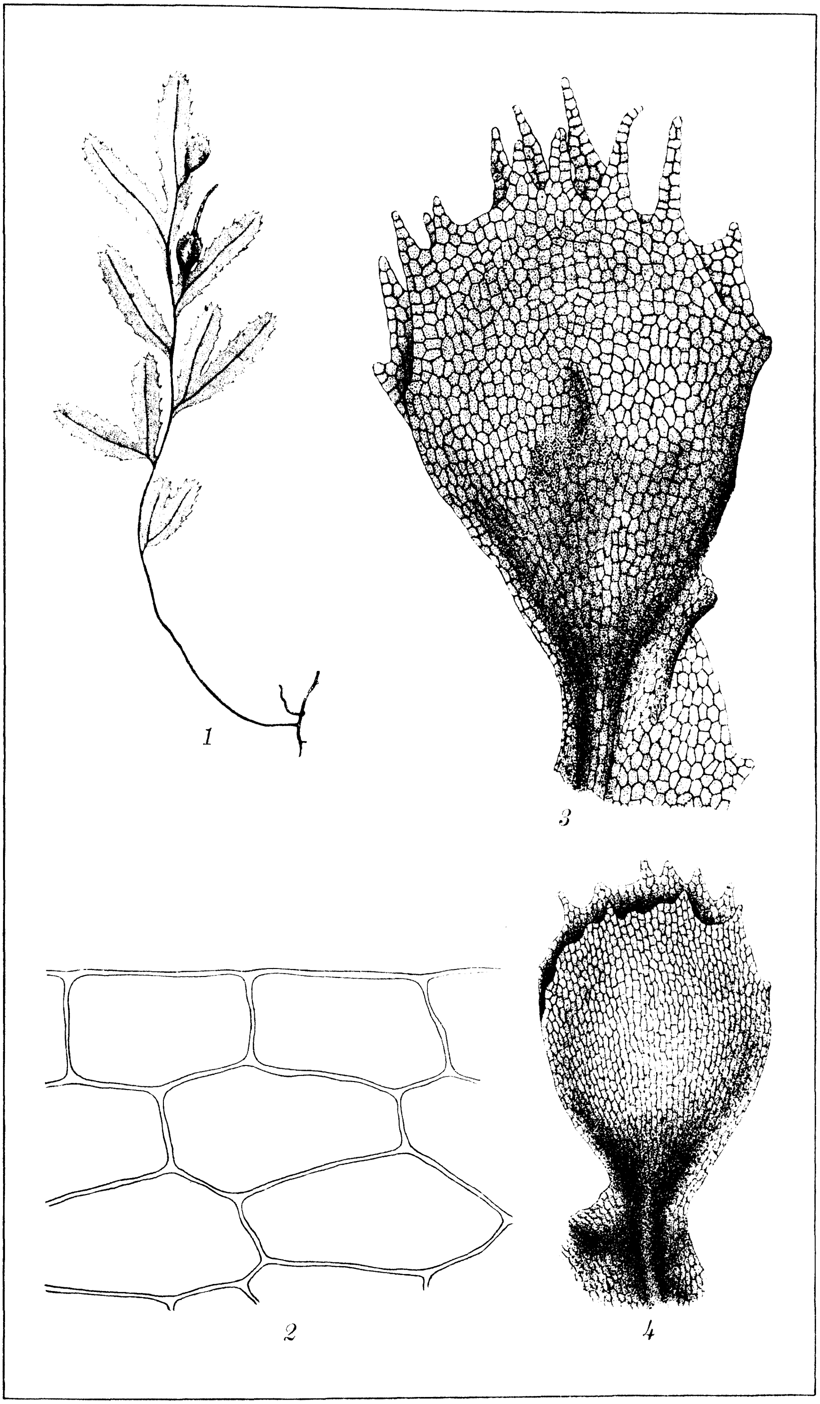

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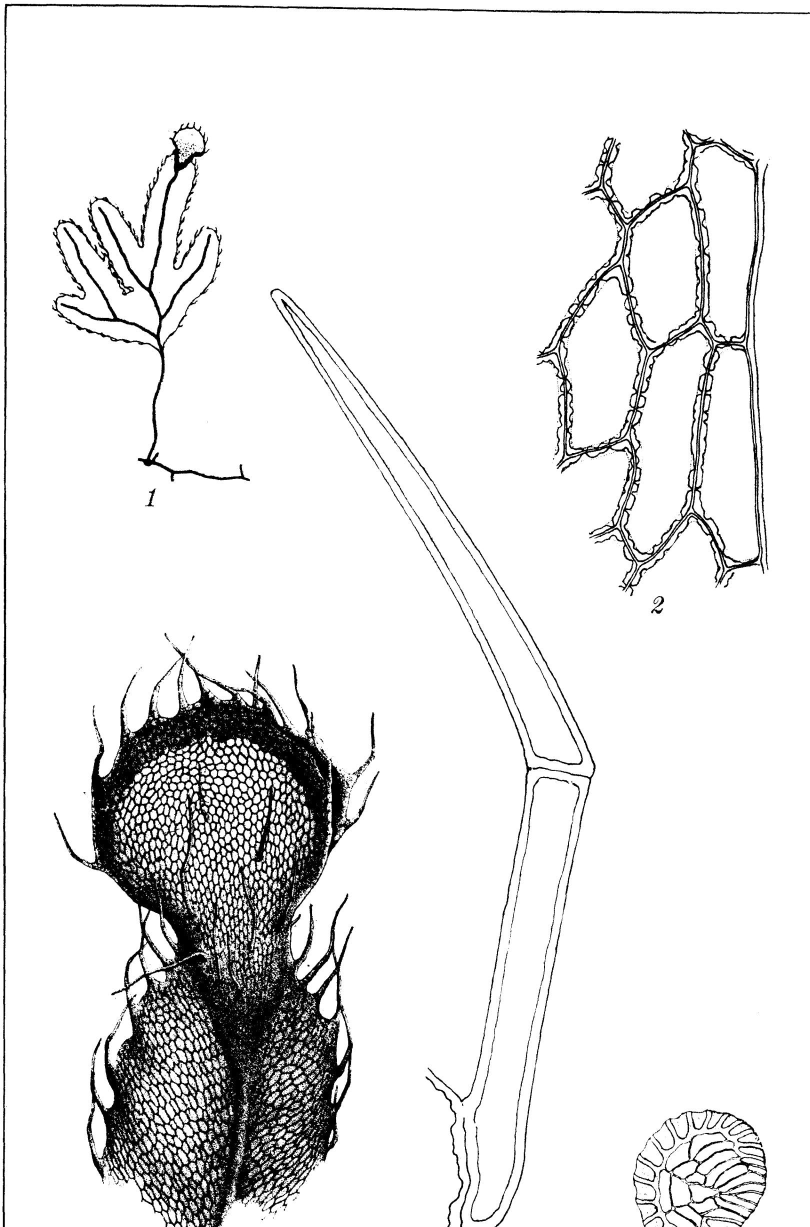
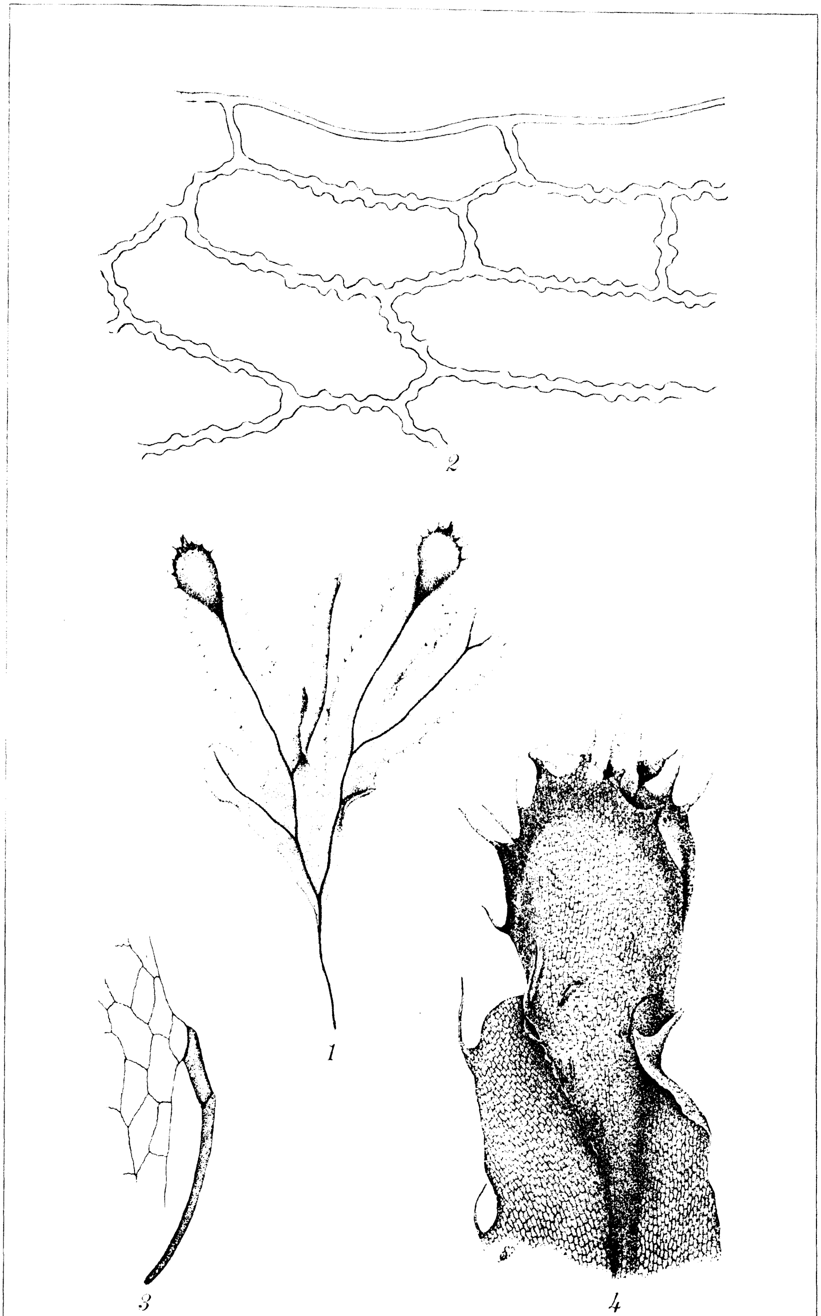


PLATE 19.



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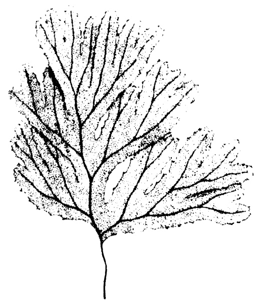

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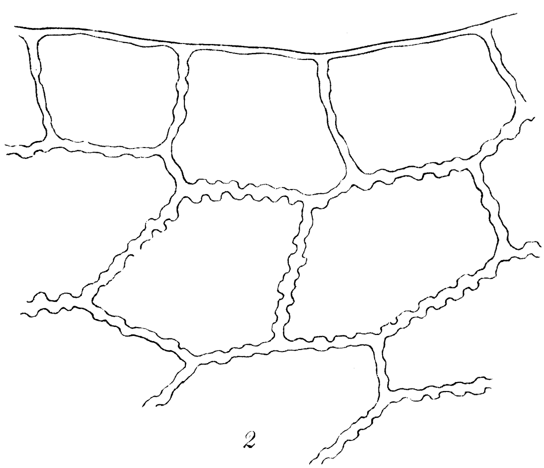

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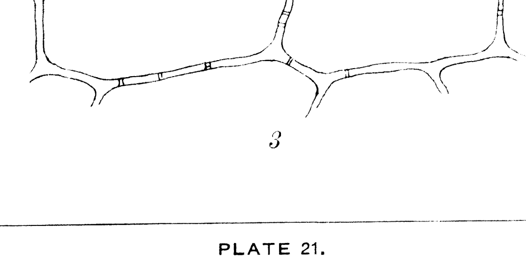

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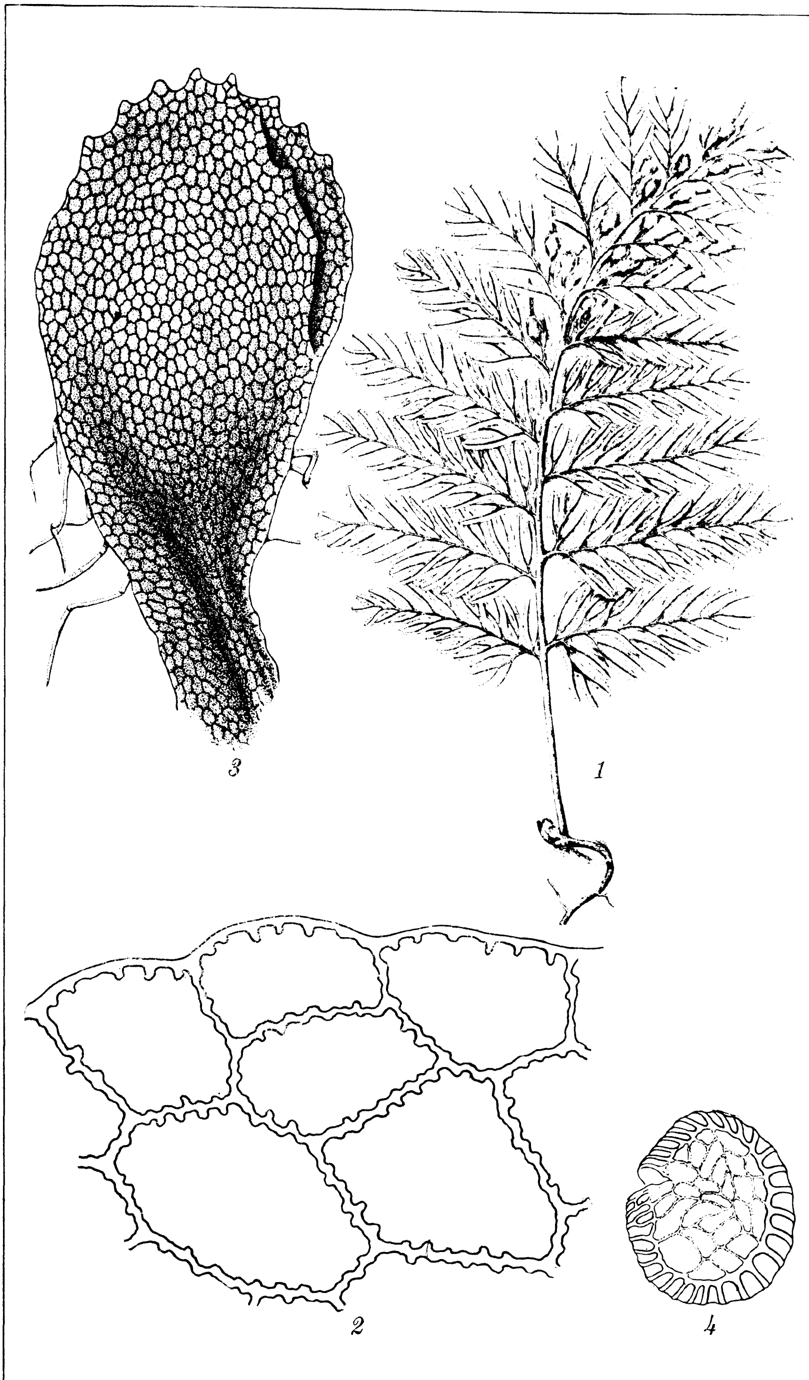

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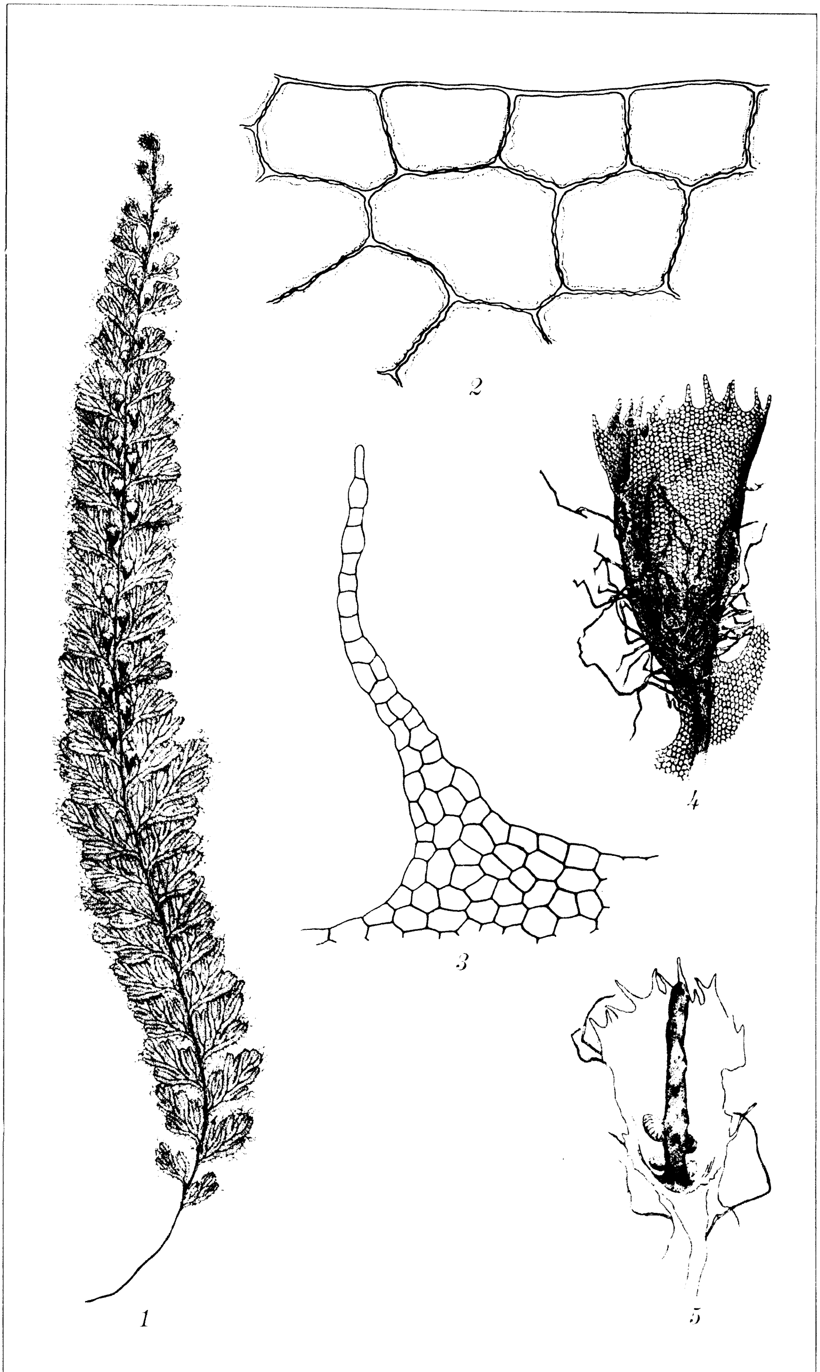

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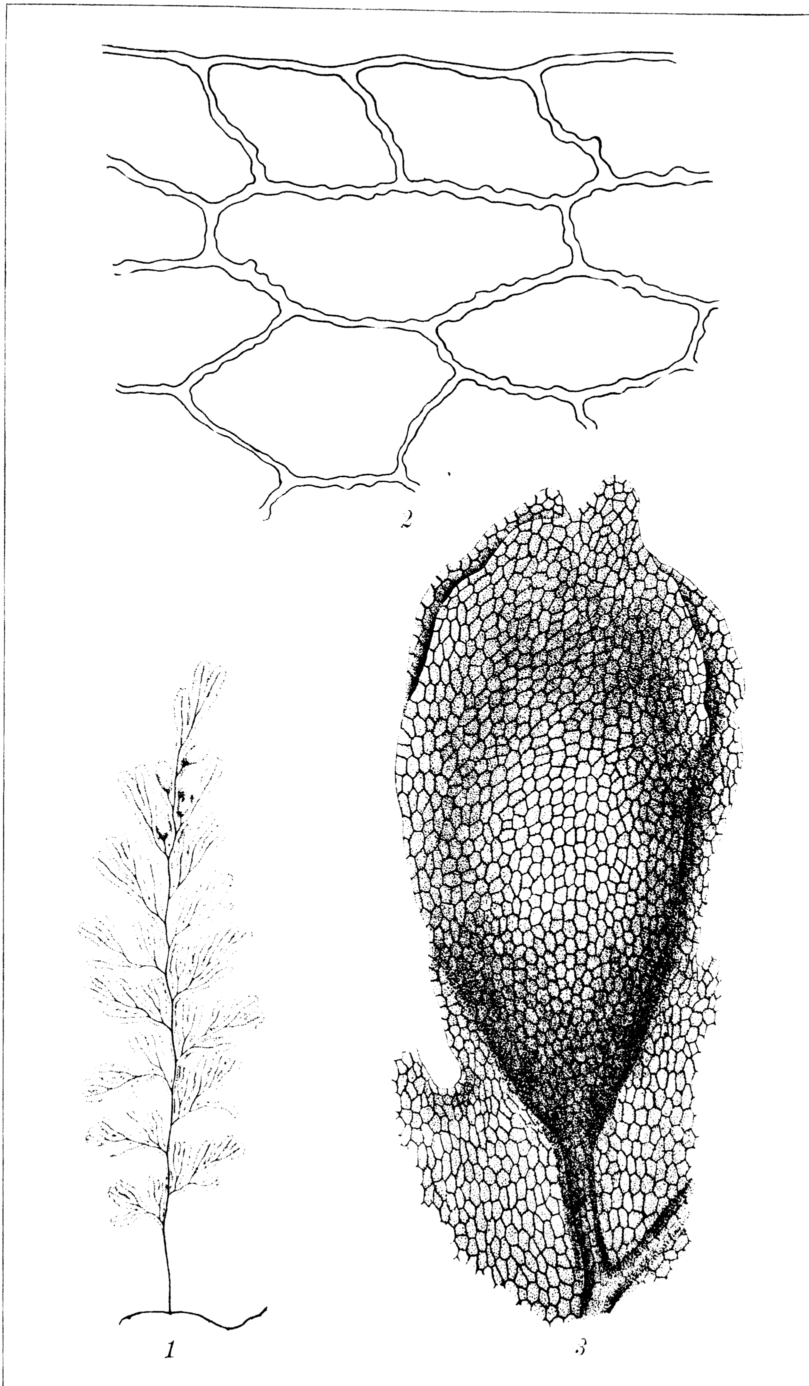

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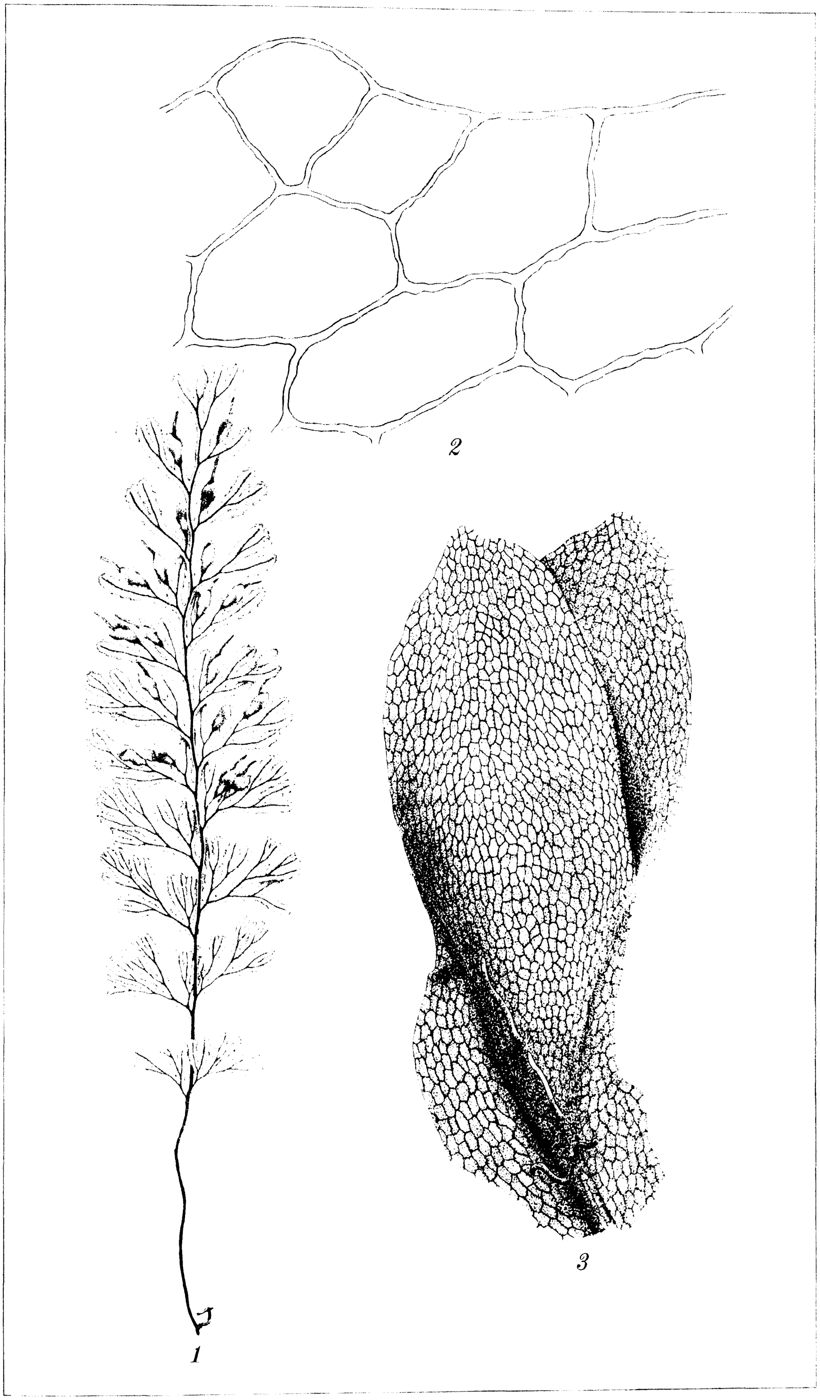

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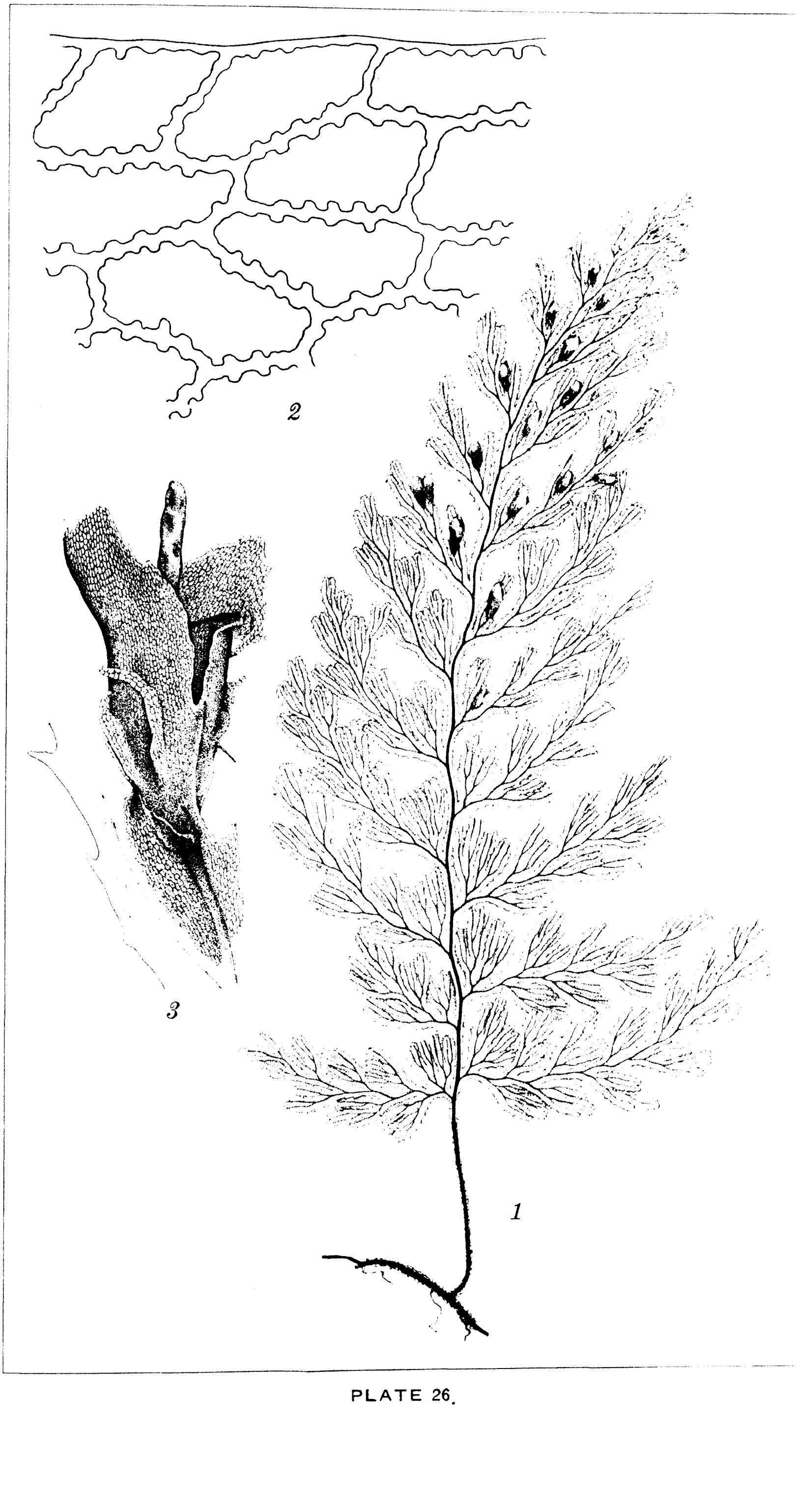

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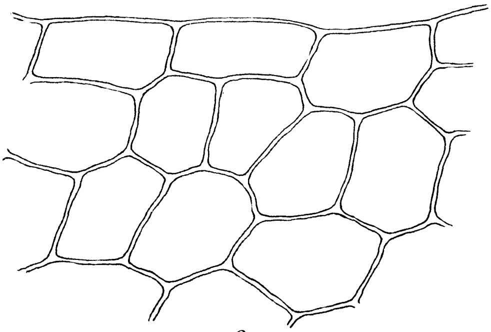

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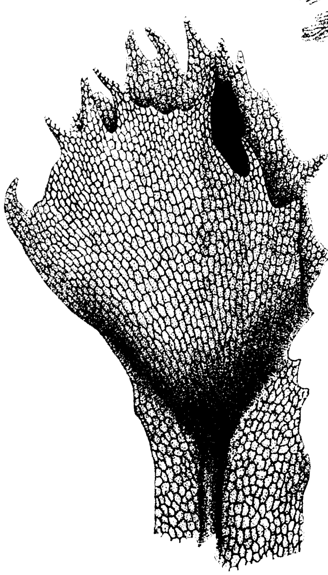

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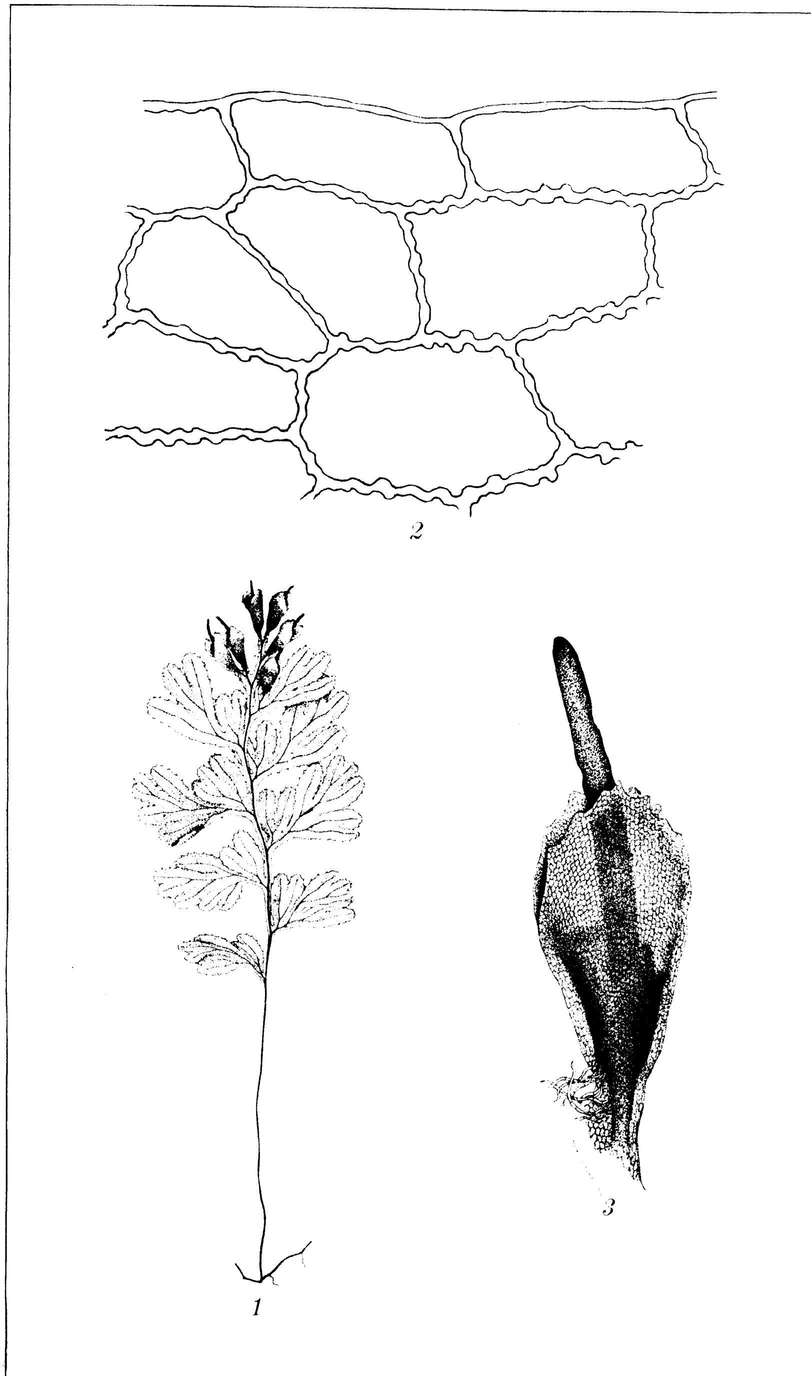

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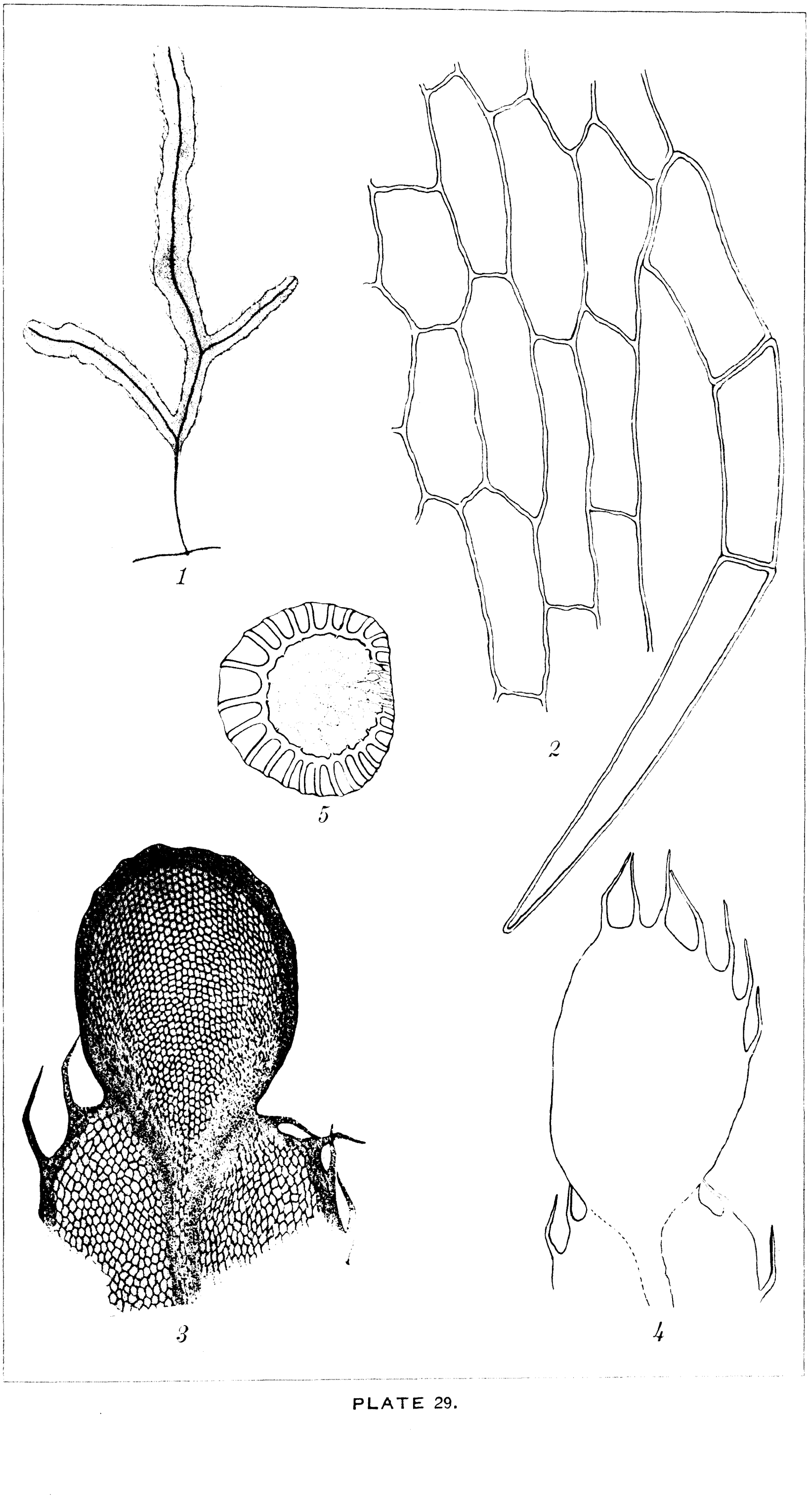

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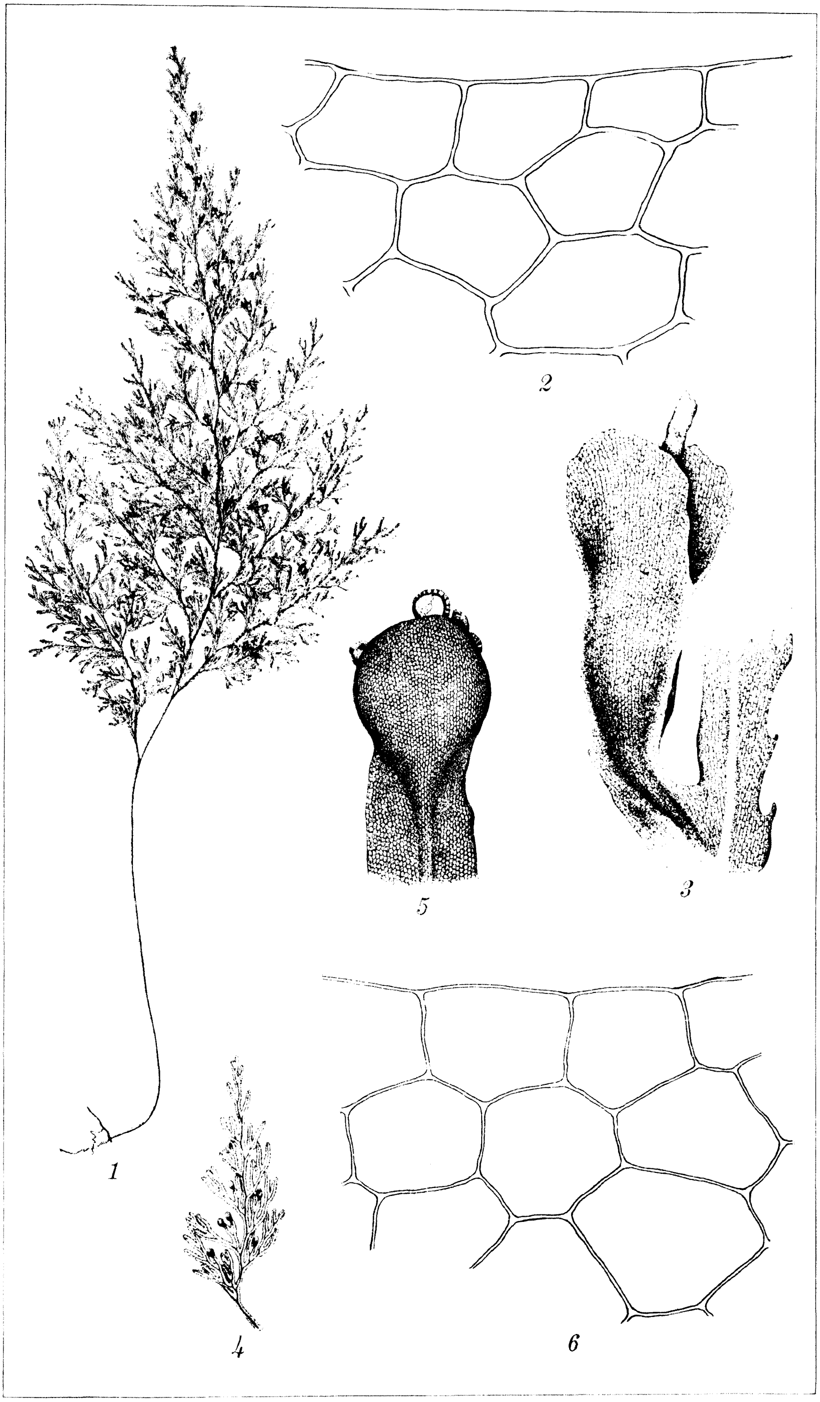

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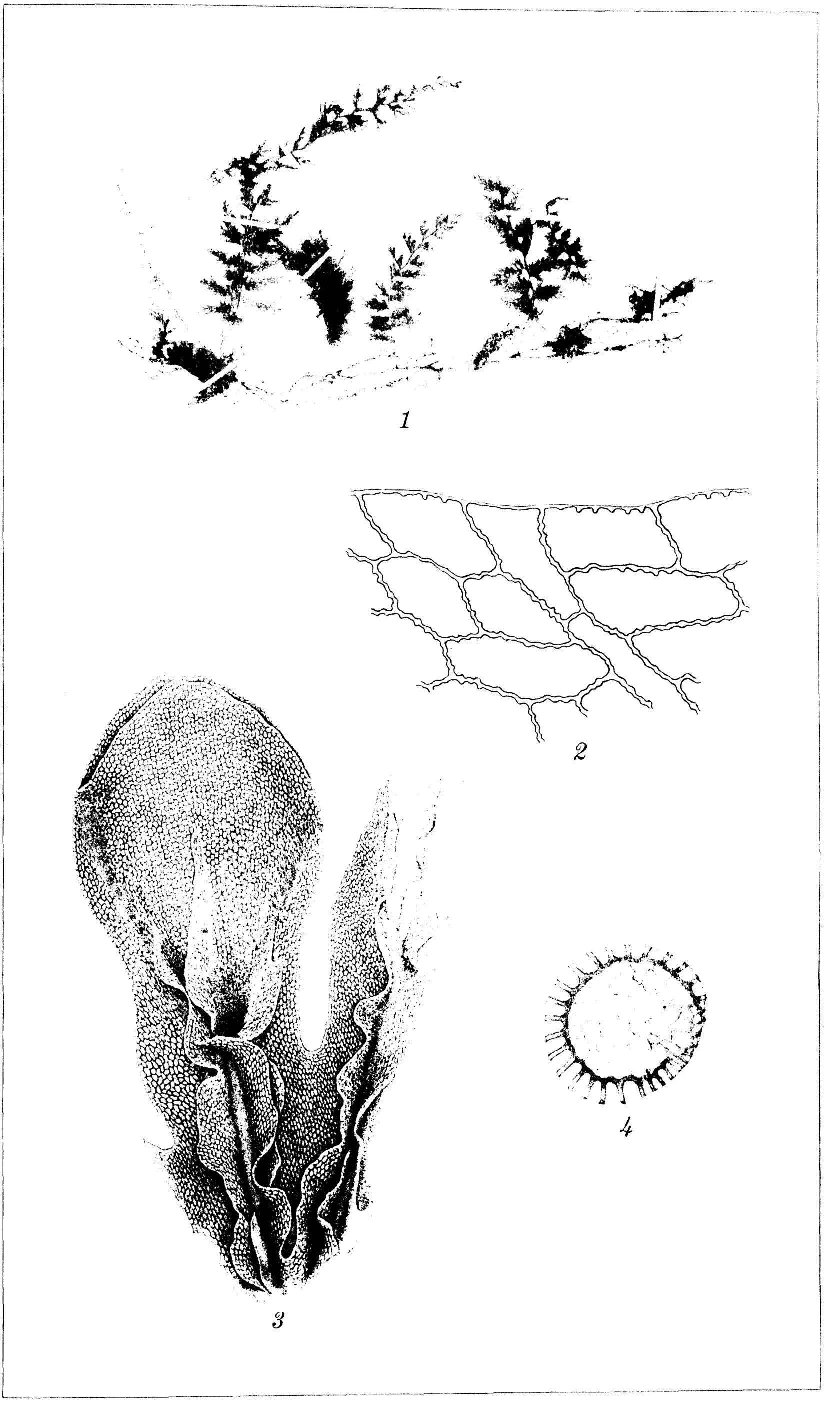

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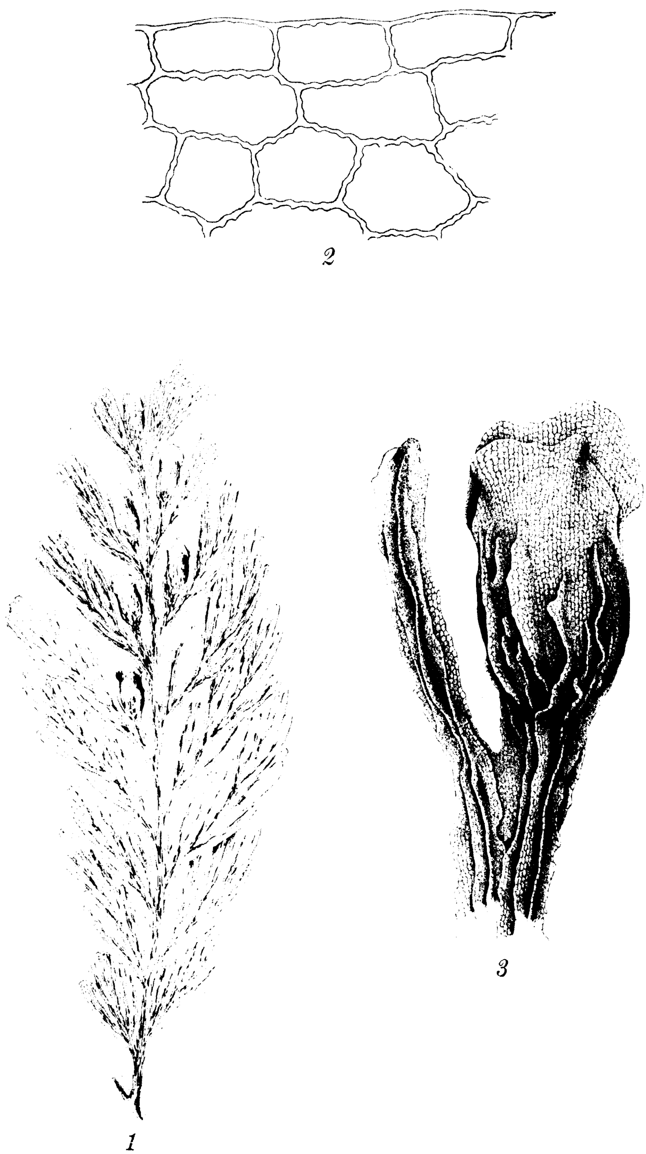

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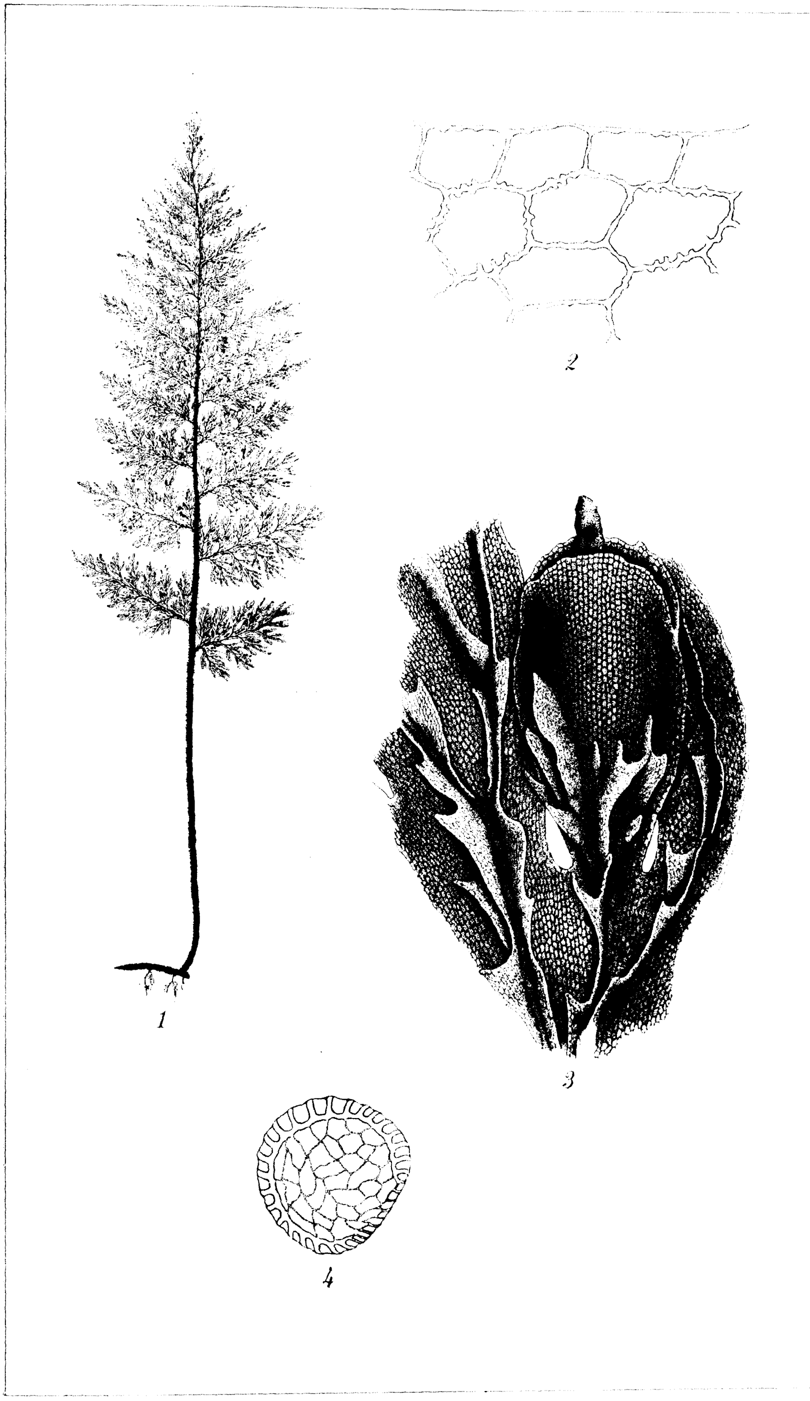

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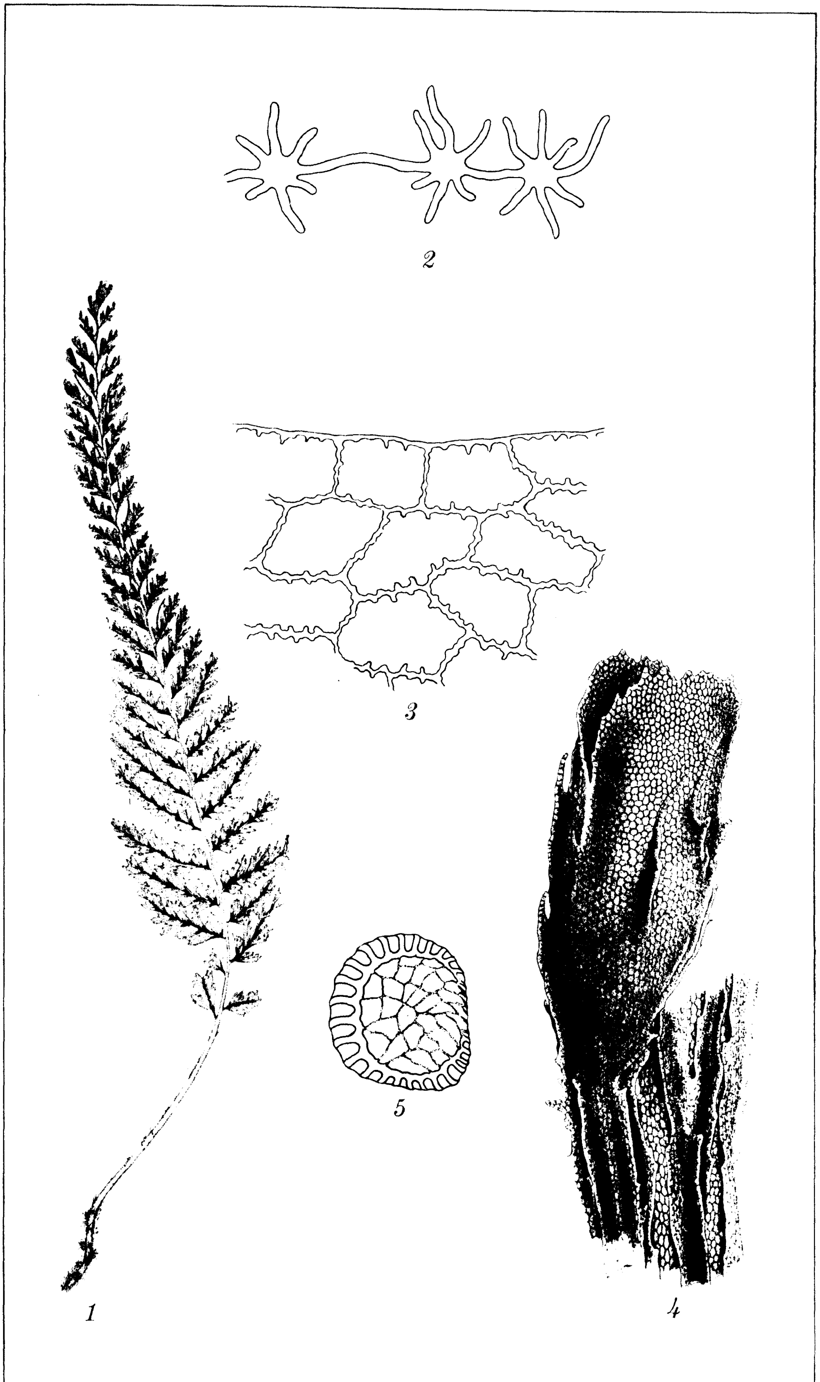

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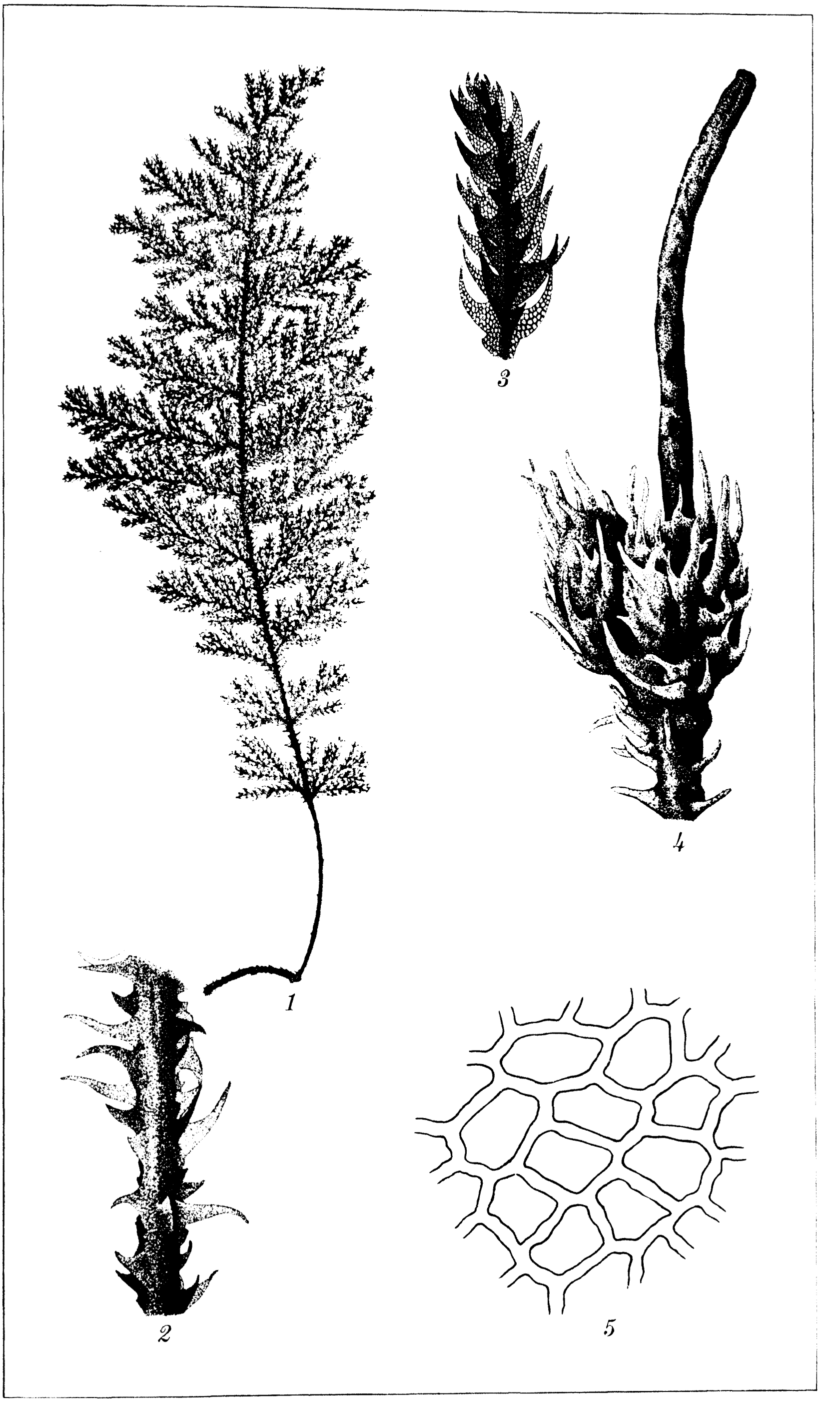

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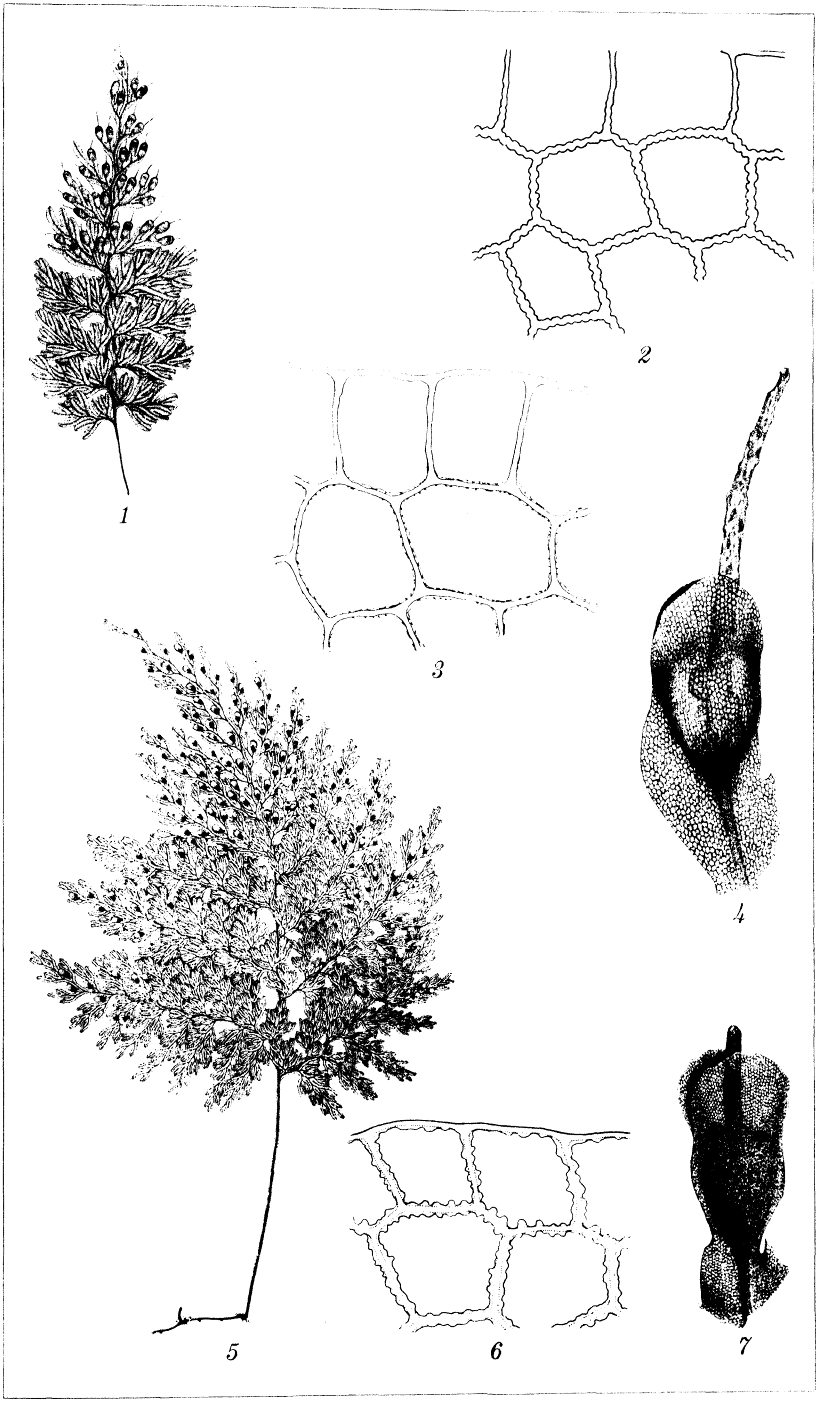

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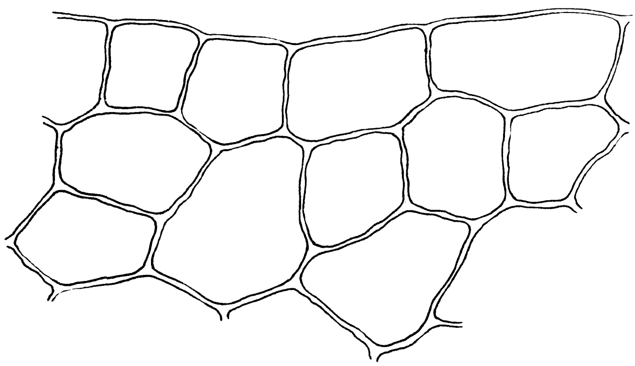

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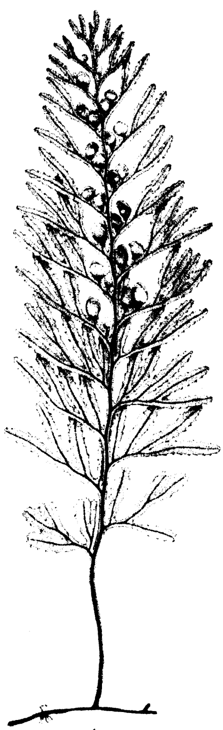

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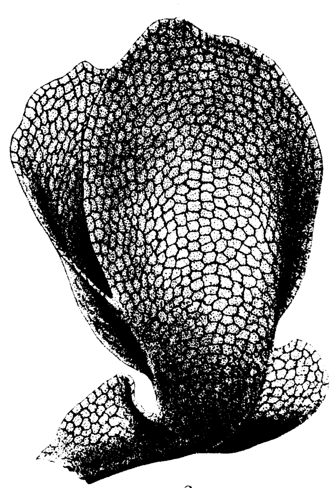

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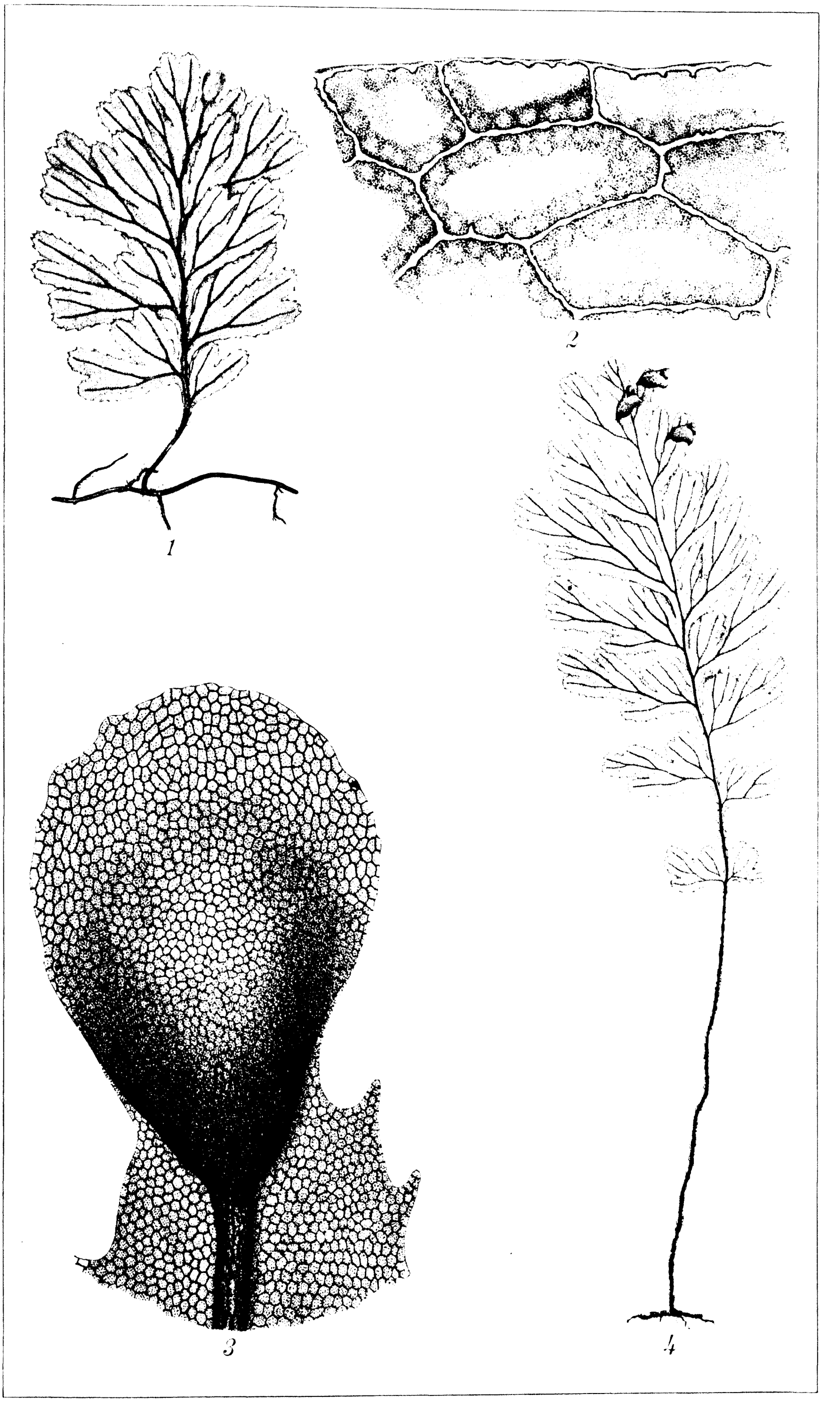

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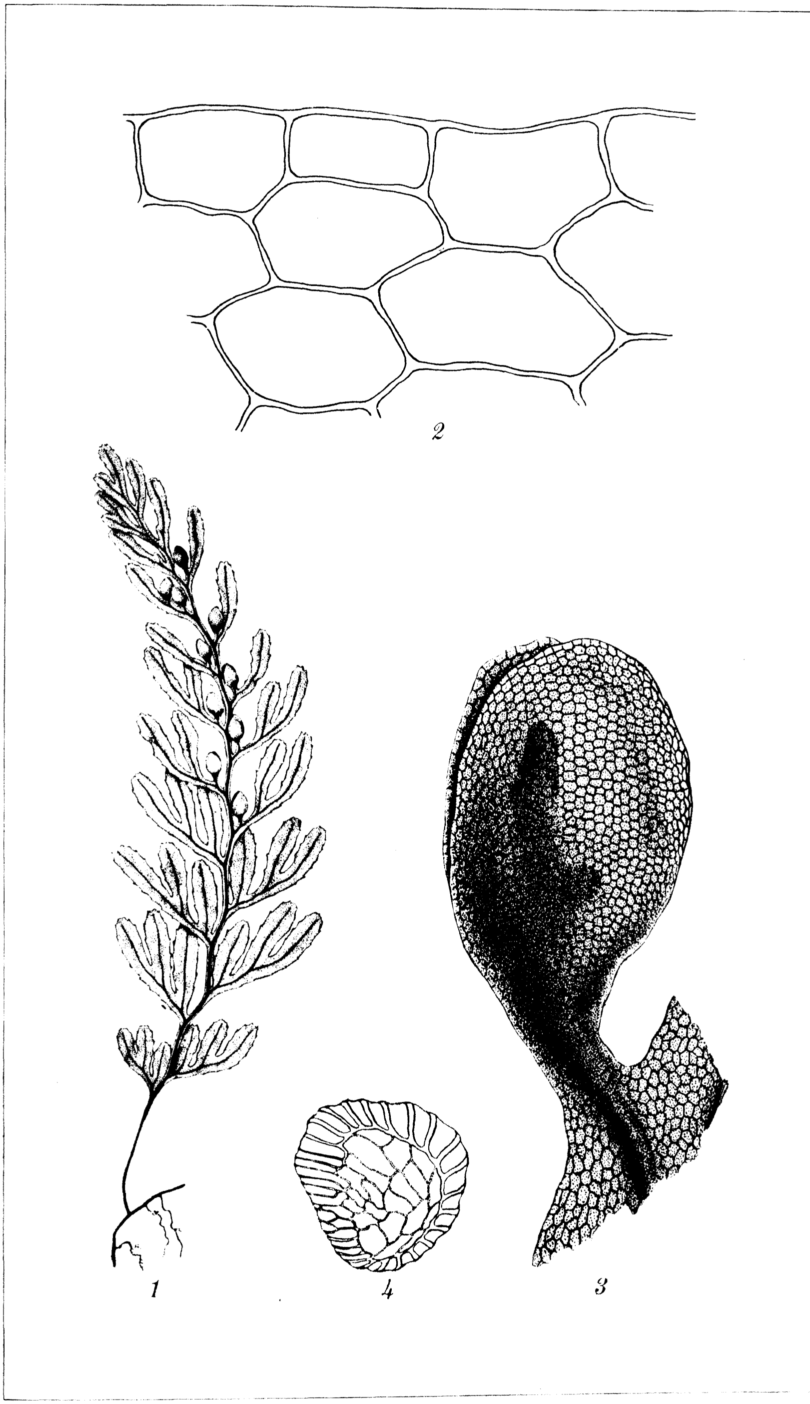

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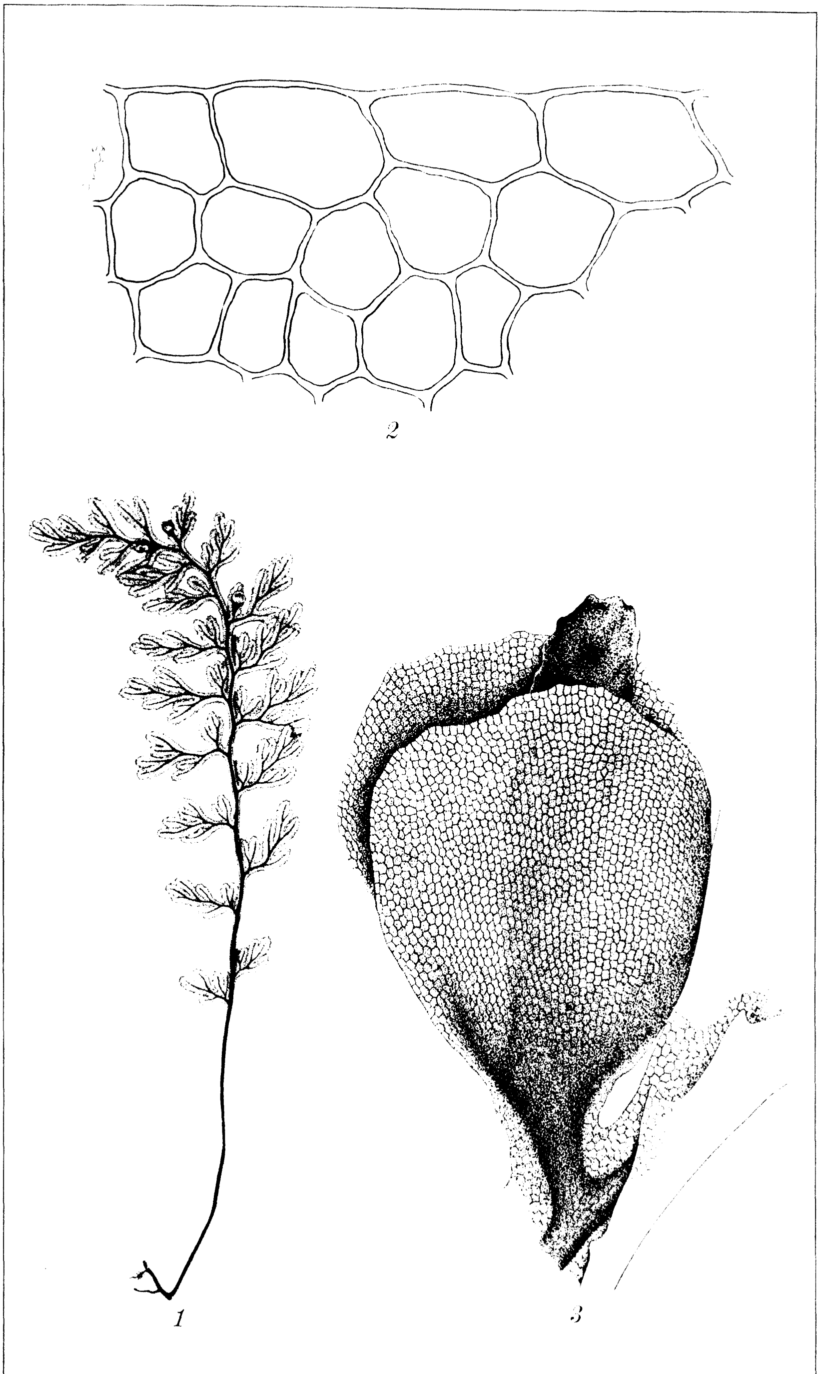

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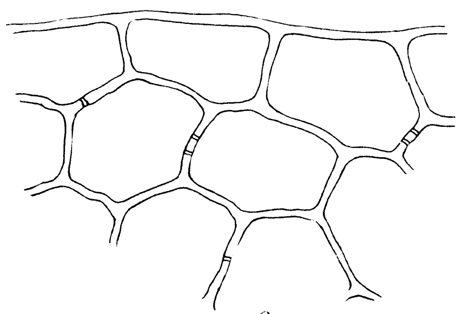

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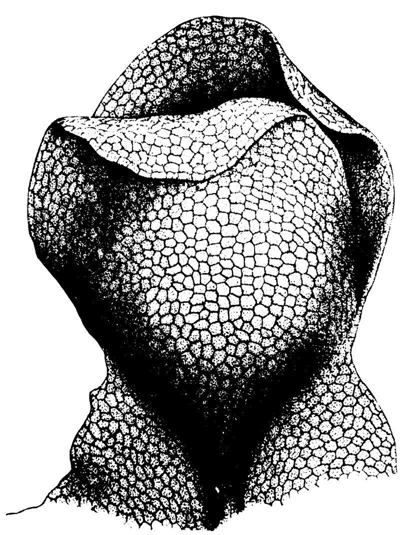

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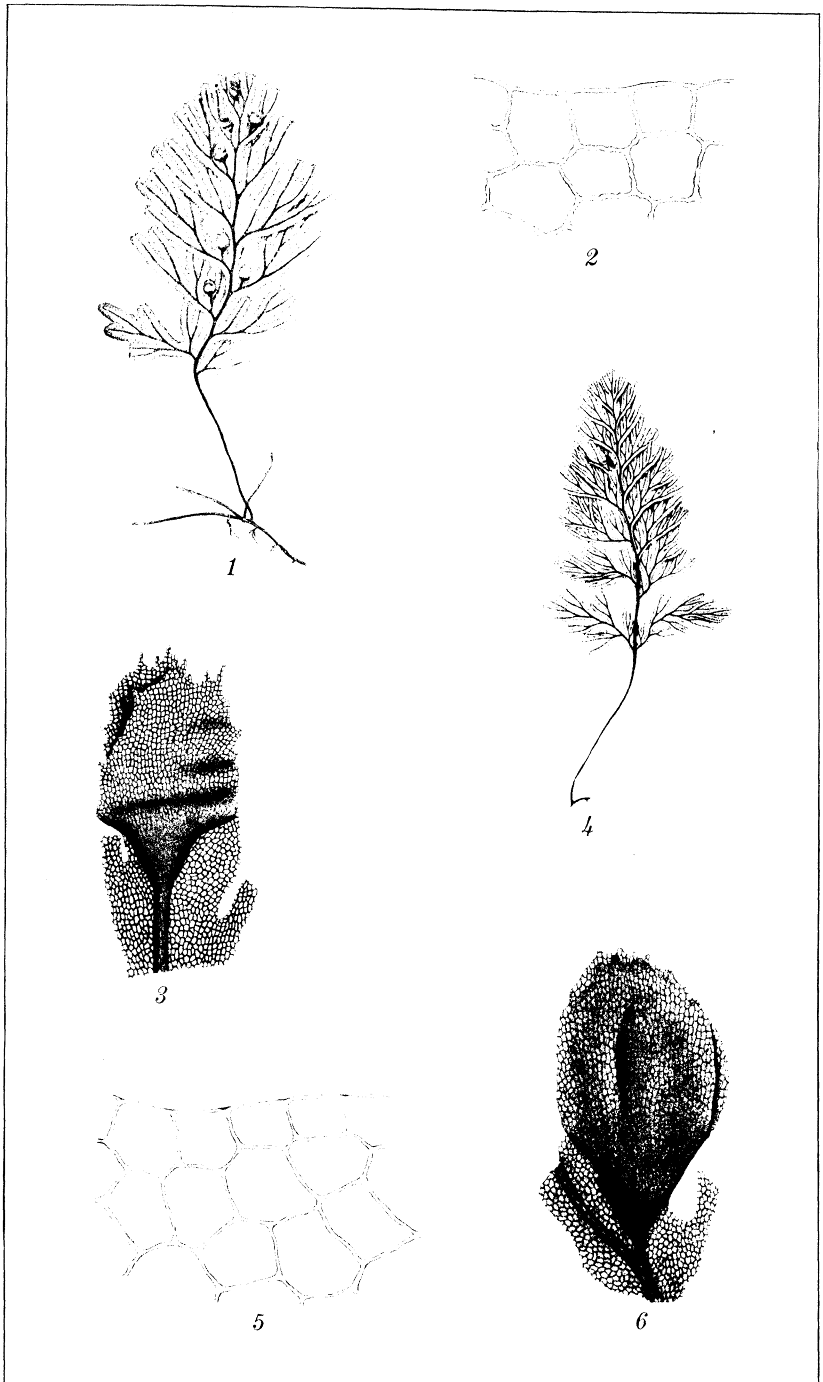

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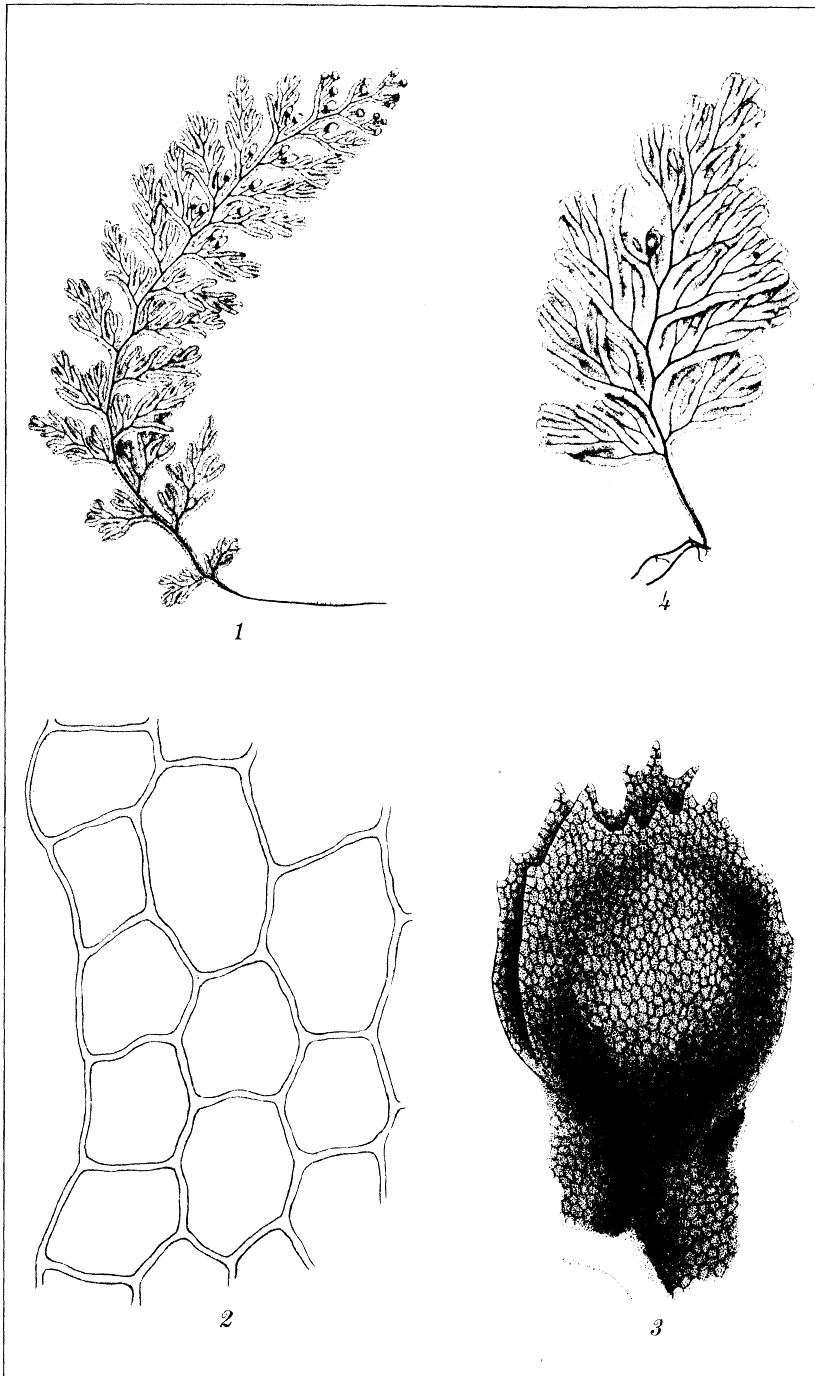

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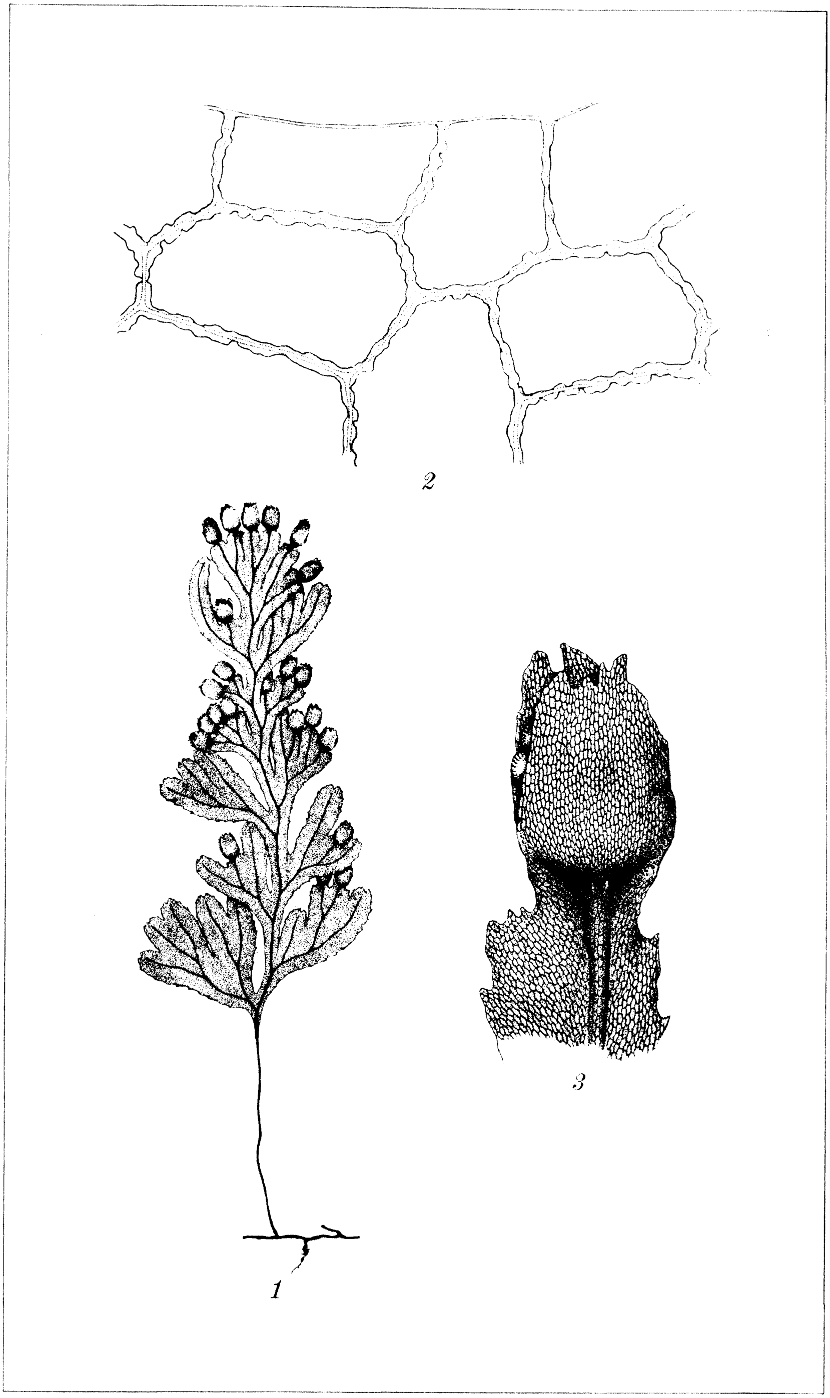

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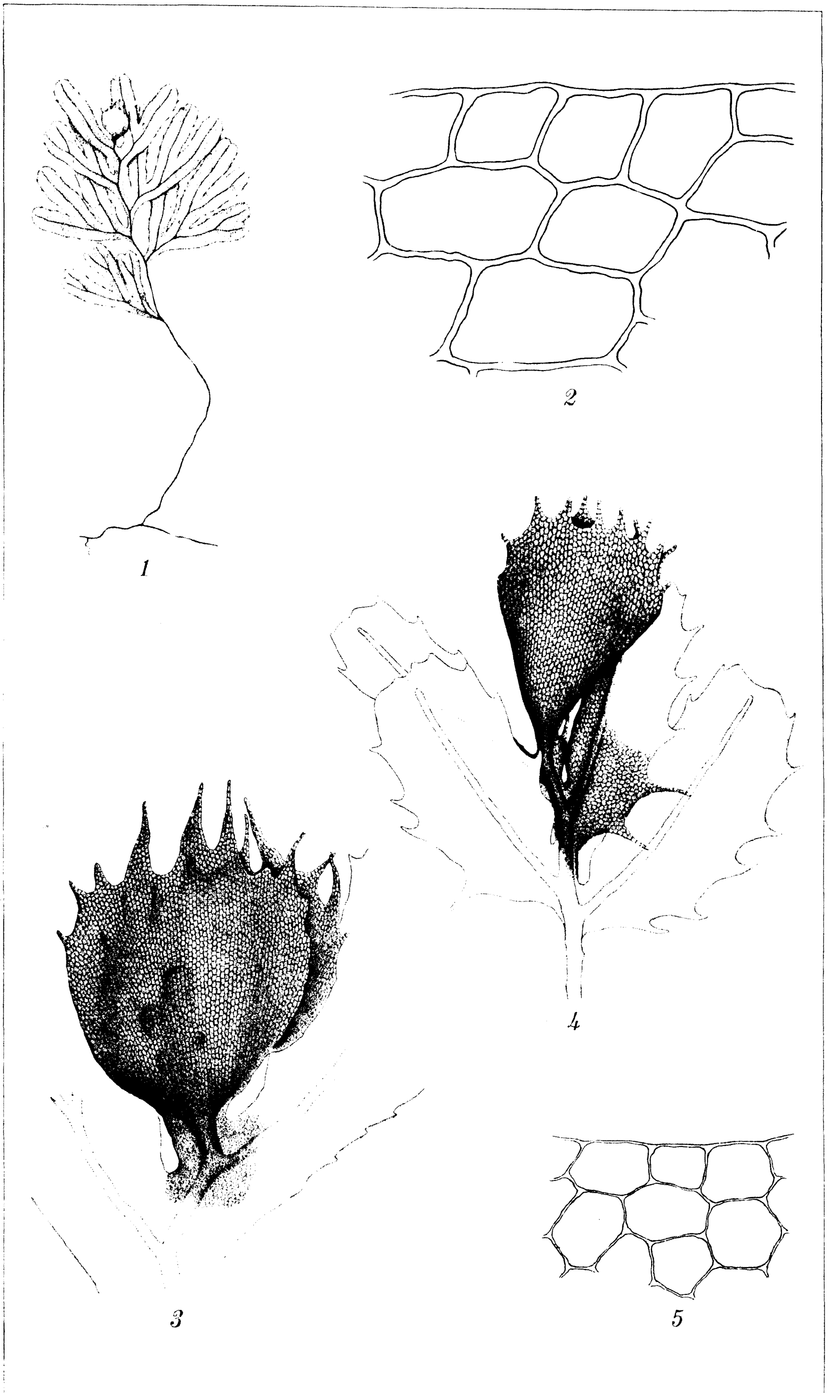

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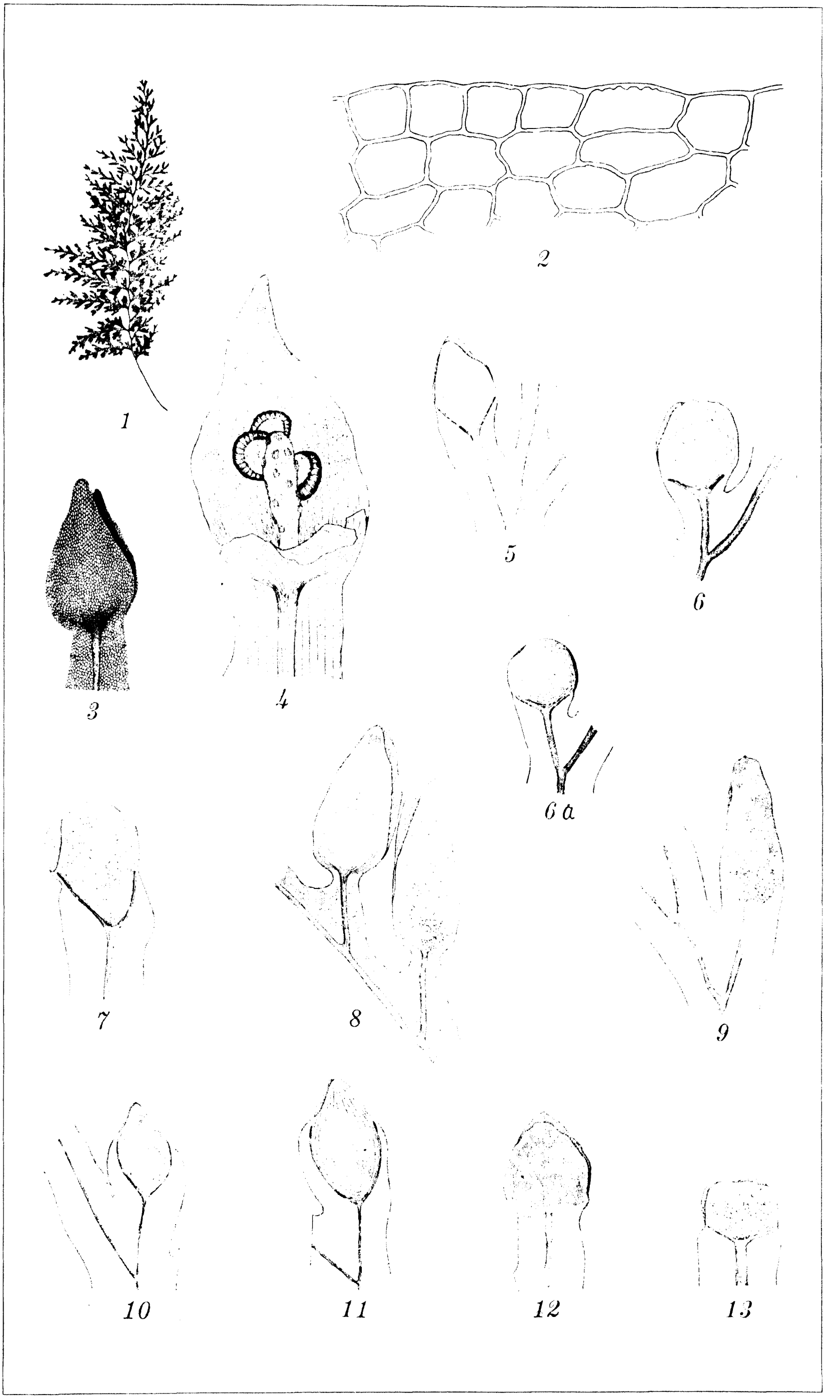

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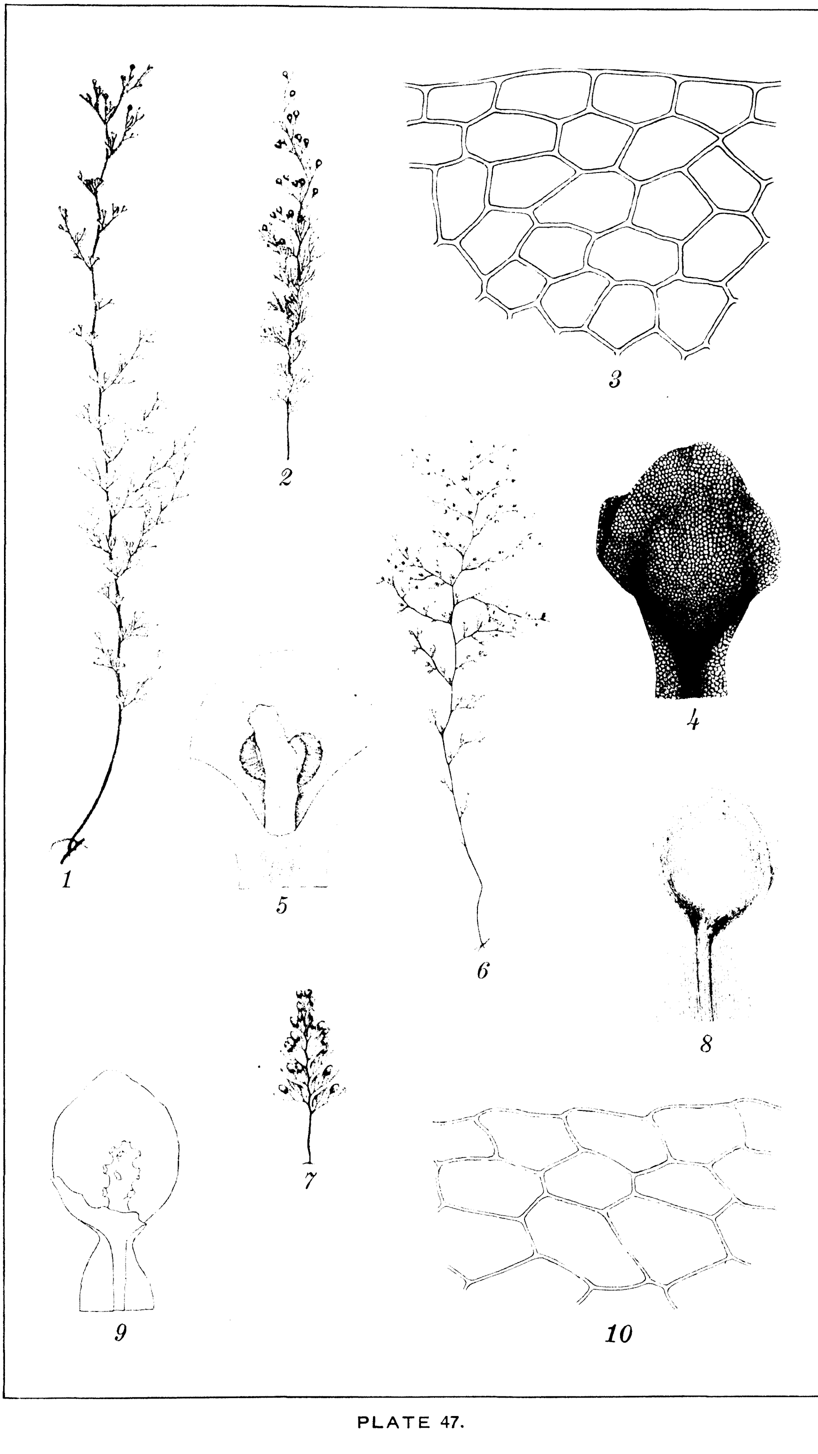

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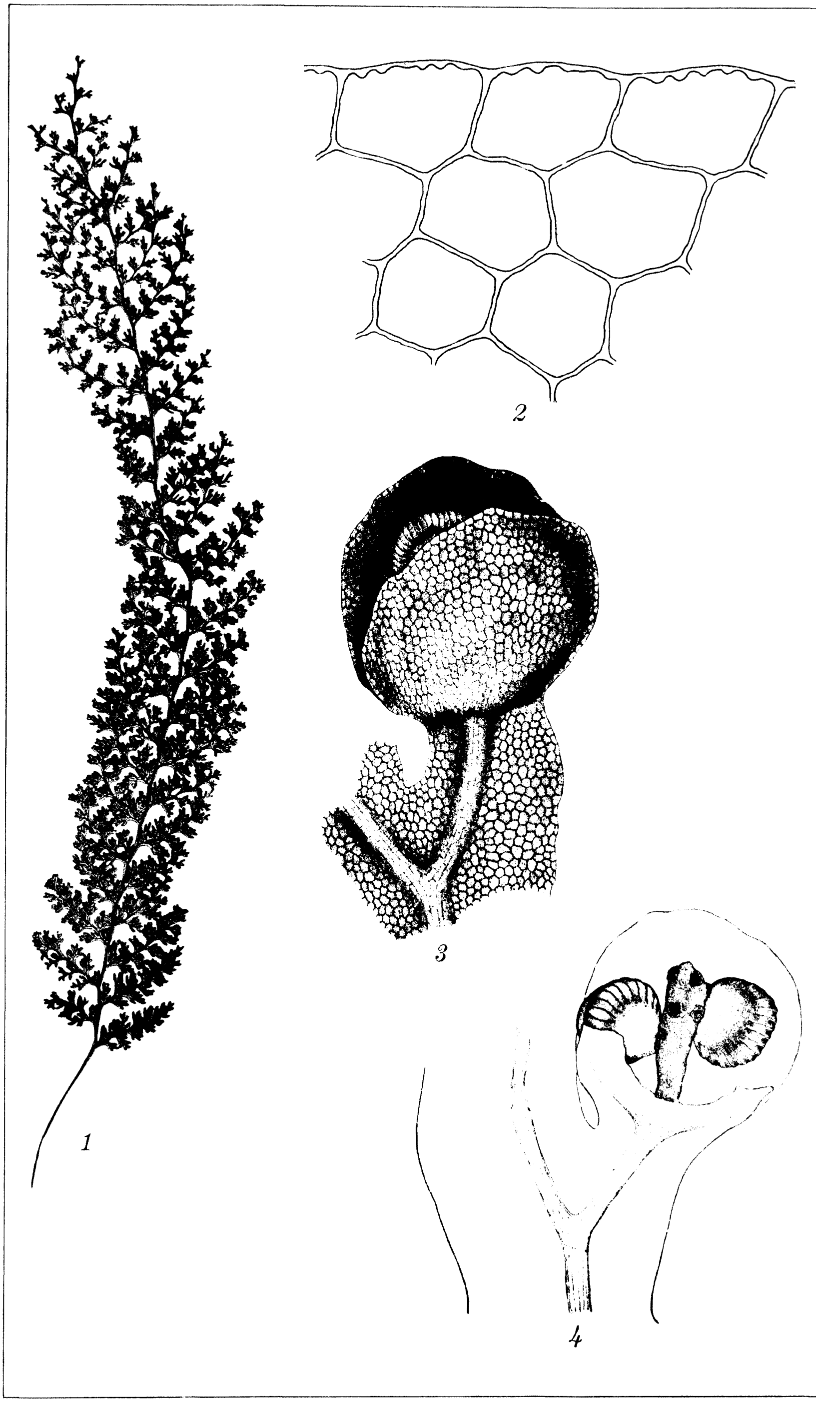

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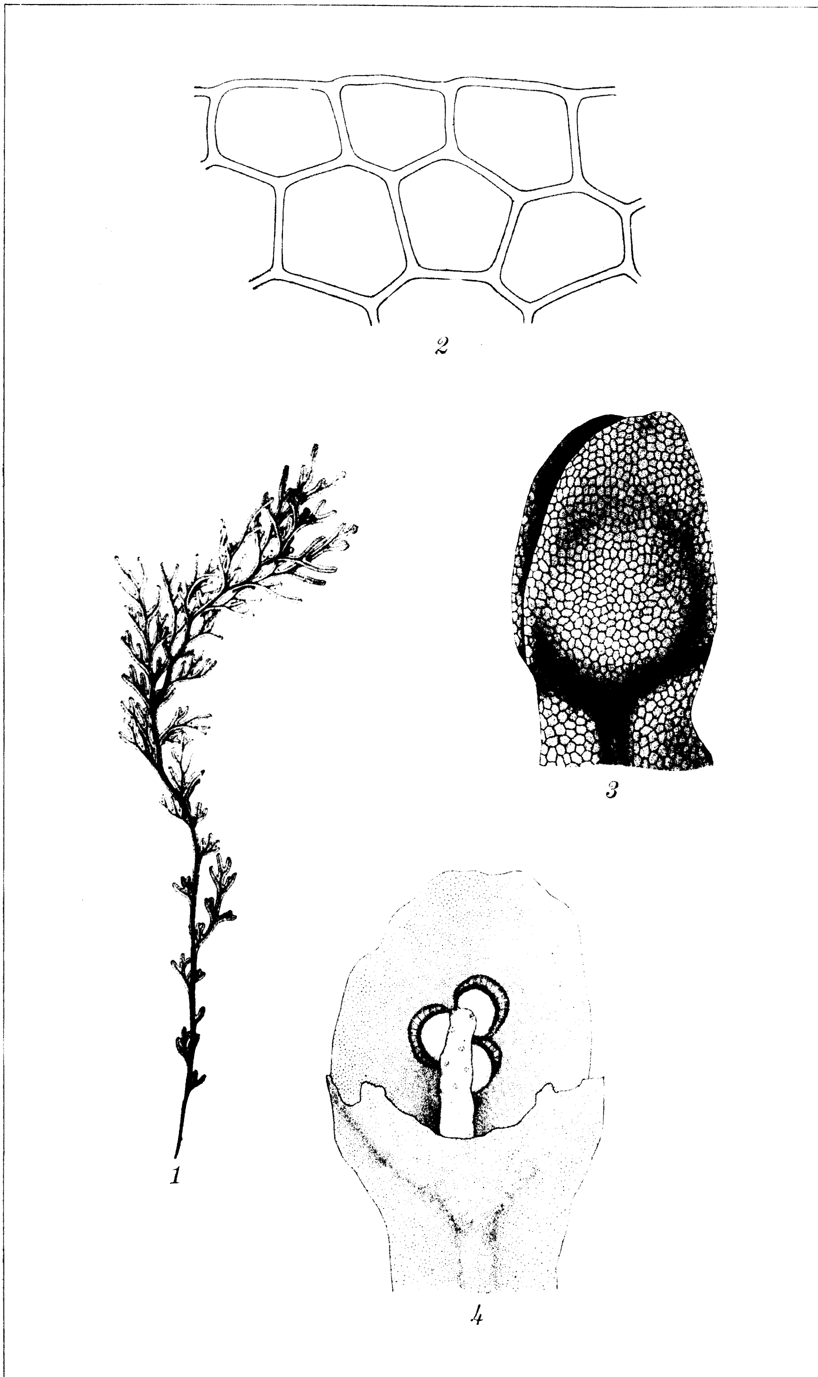

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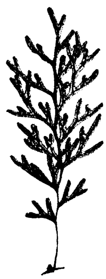

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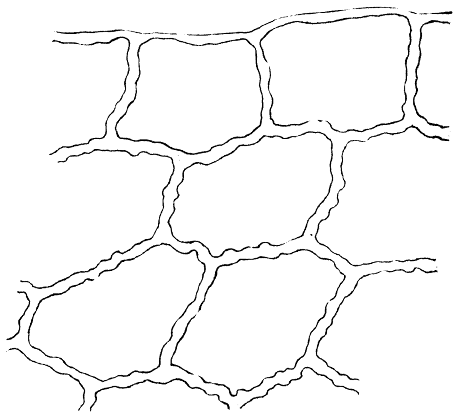

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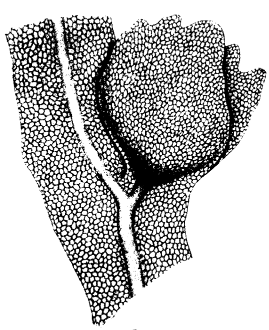

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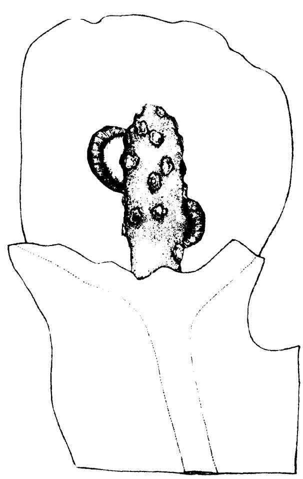

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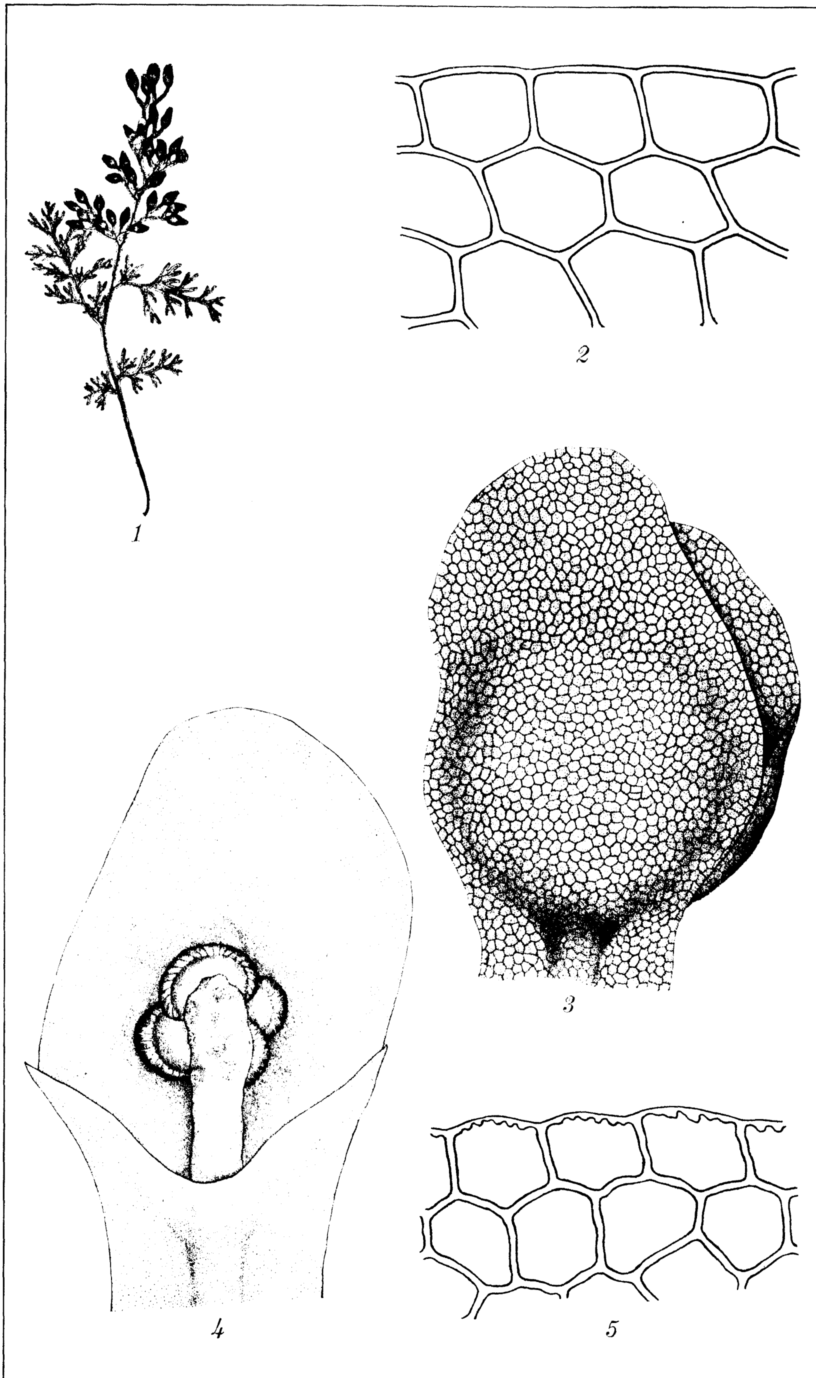

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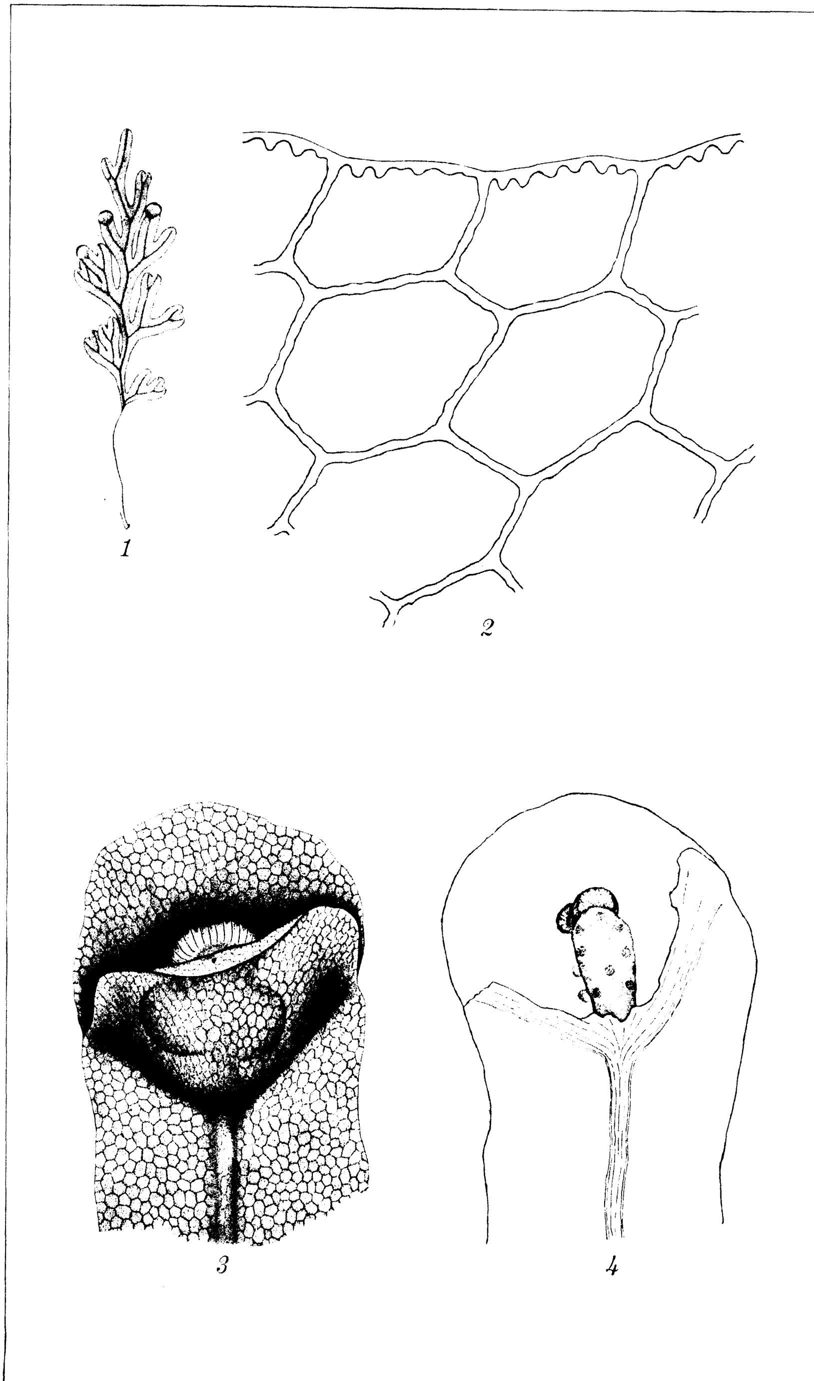

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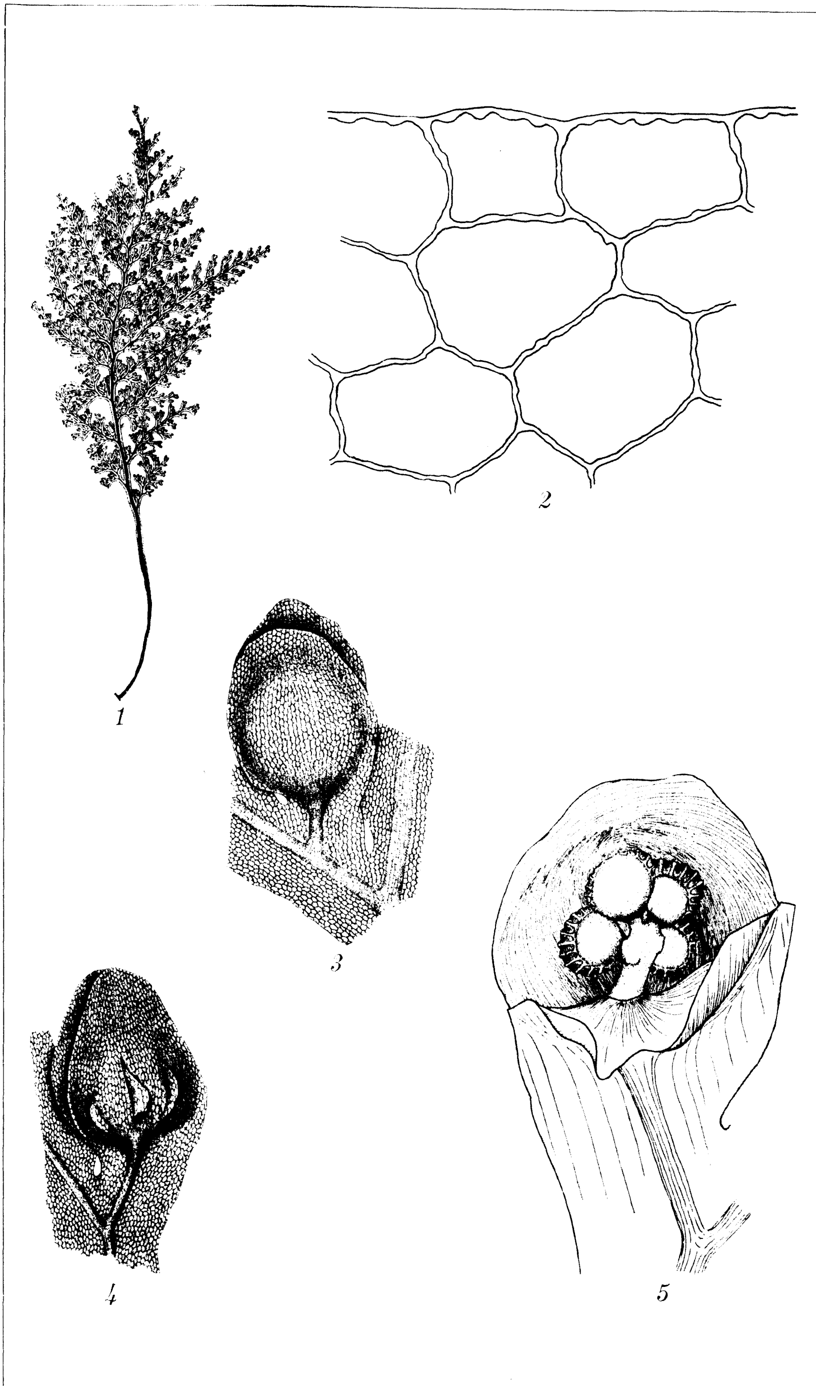

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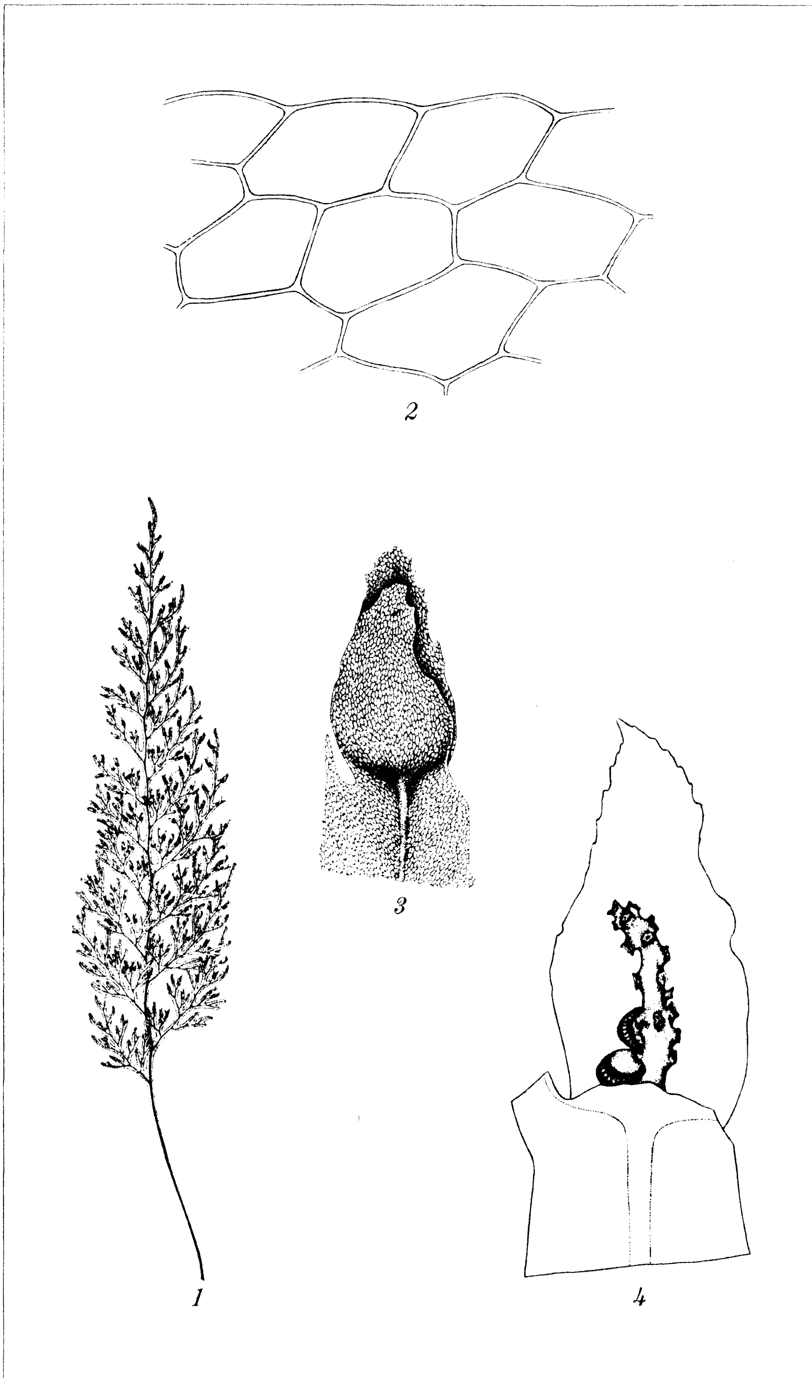

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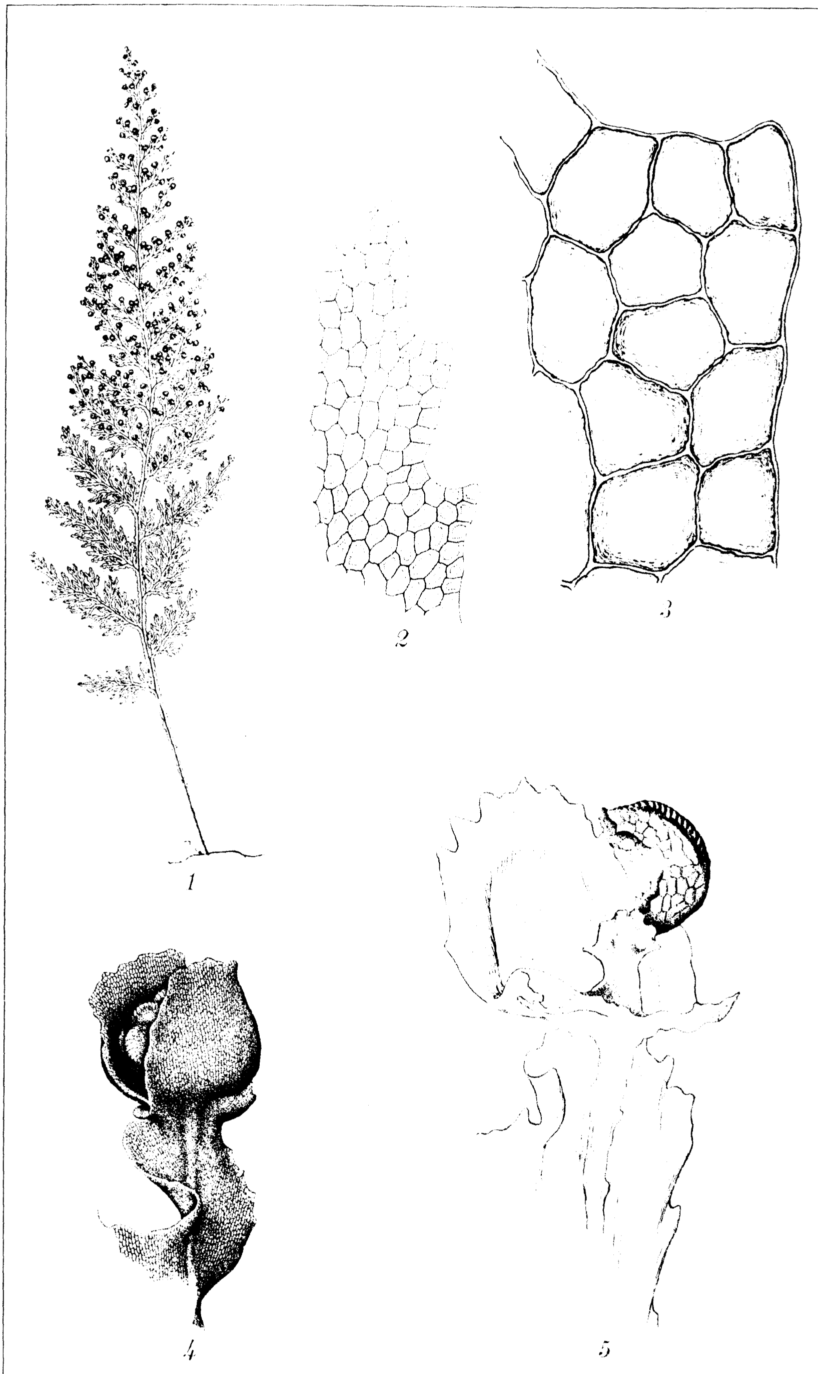

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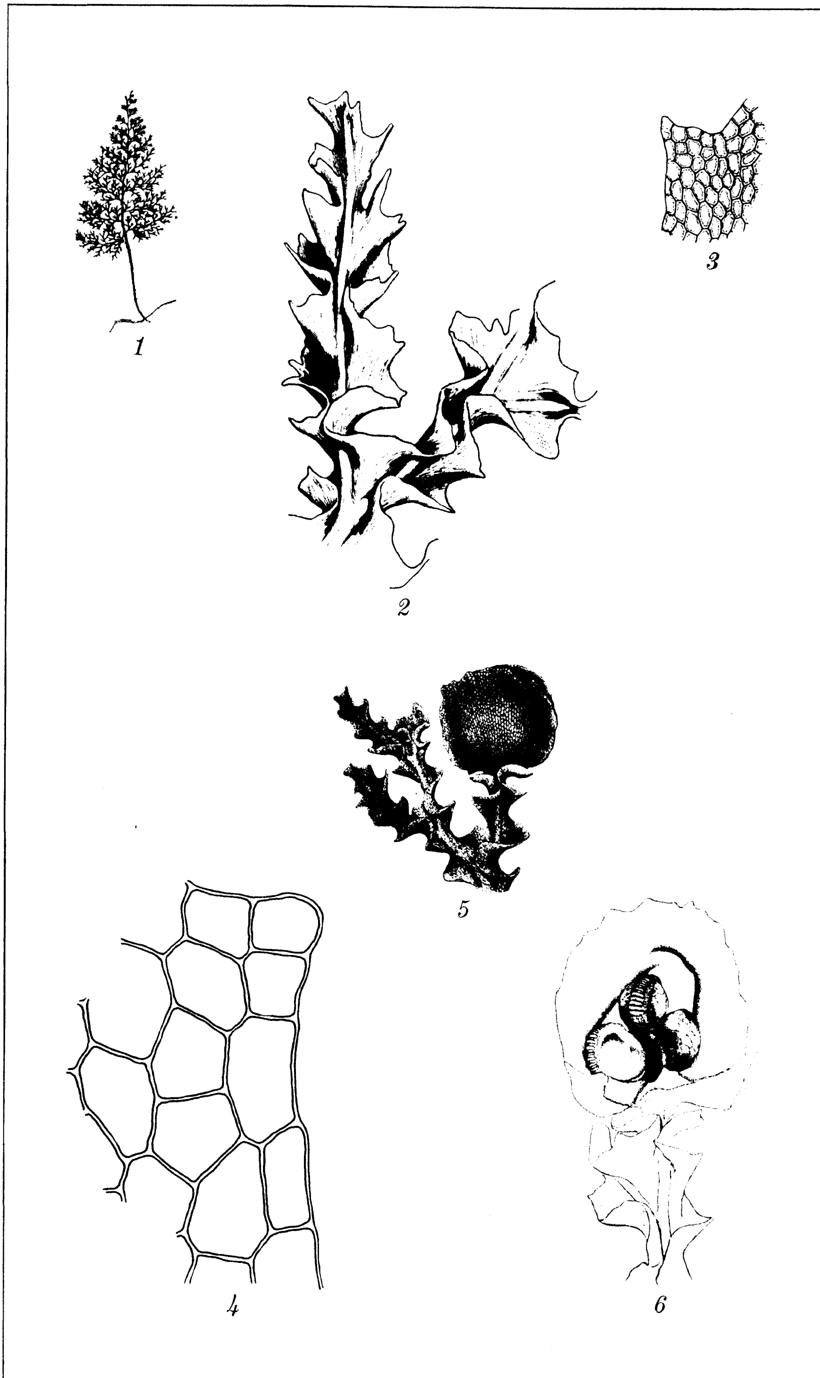

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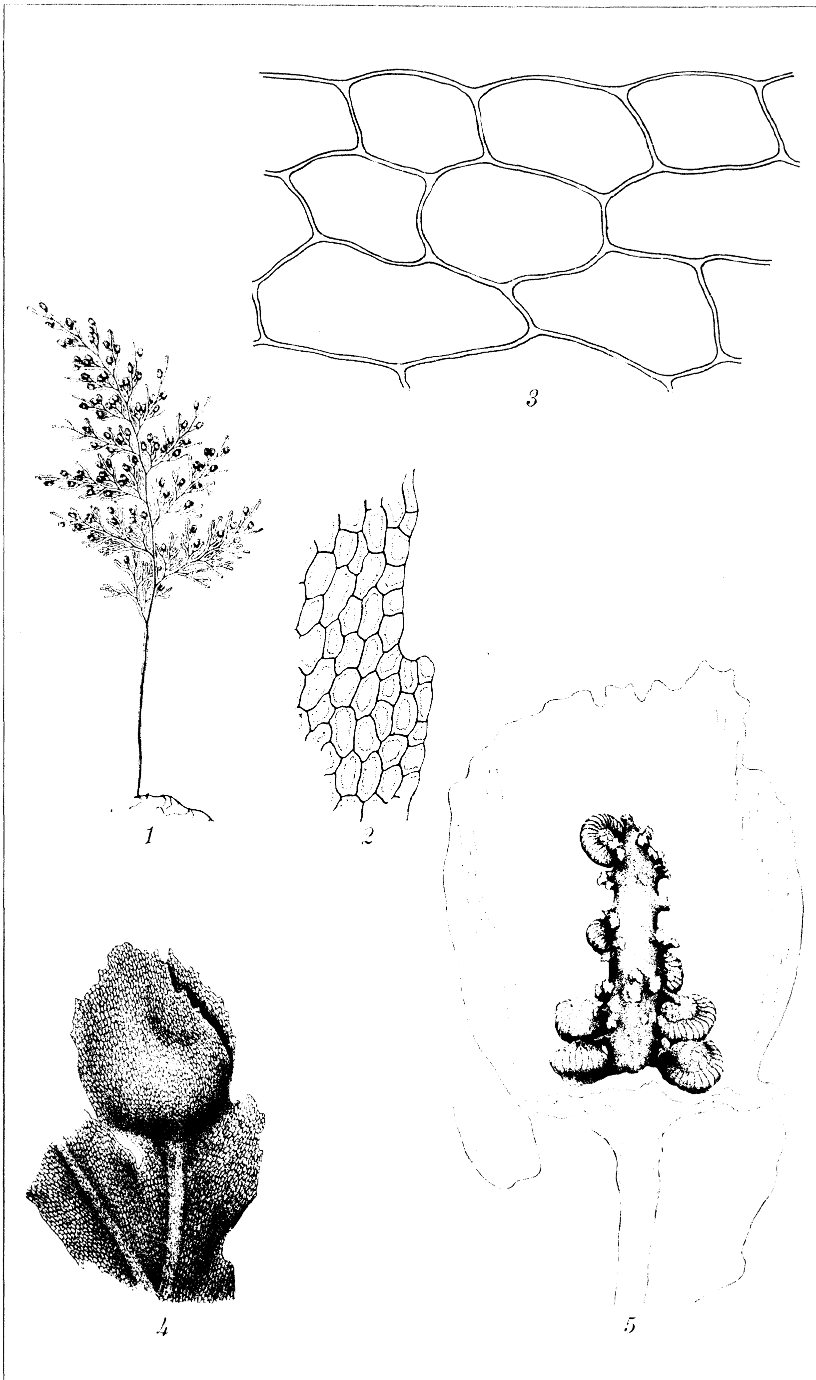

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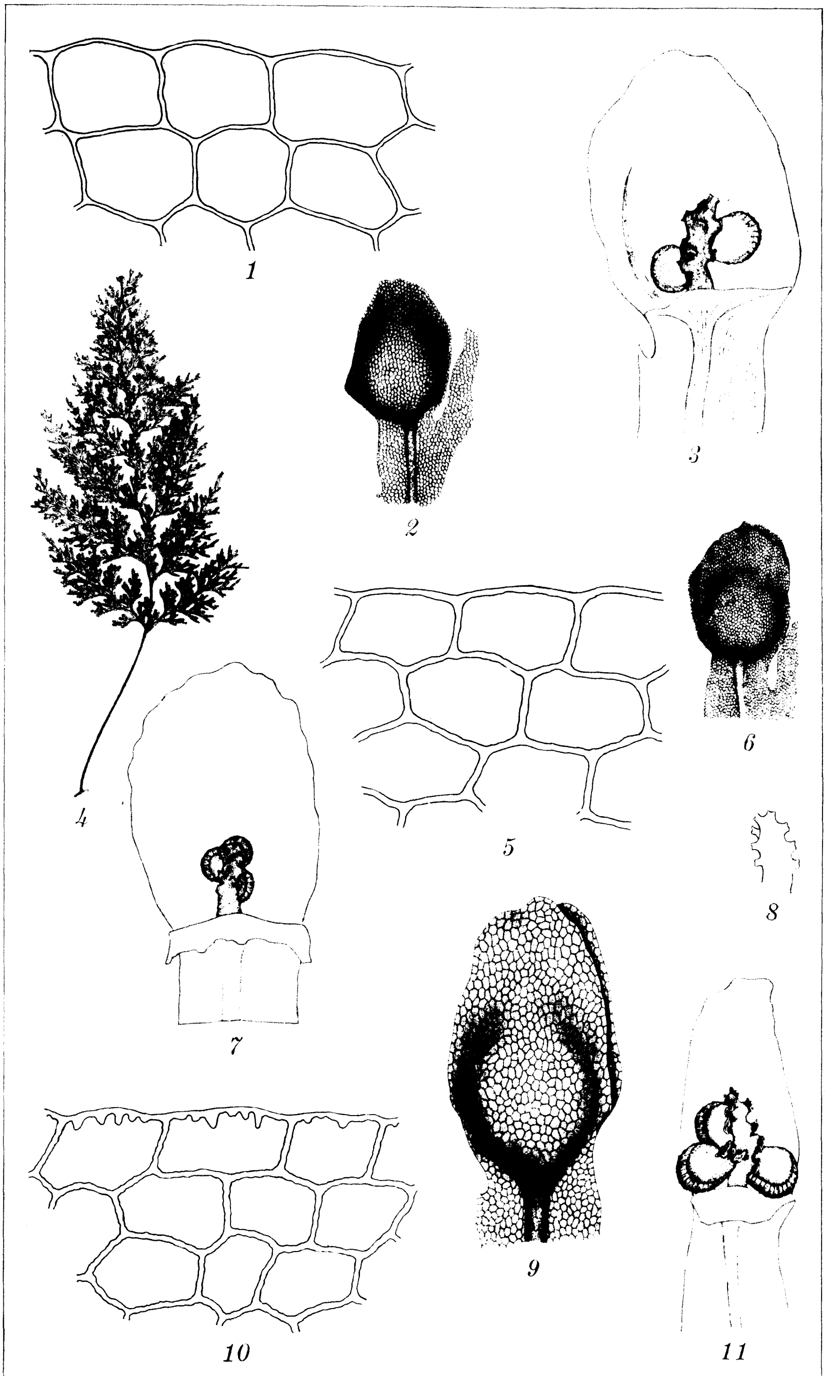

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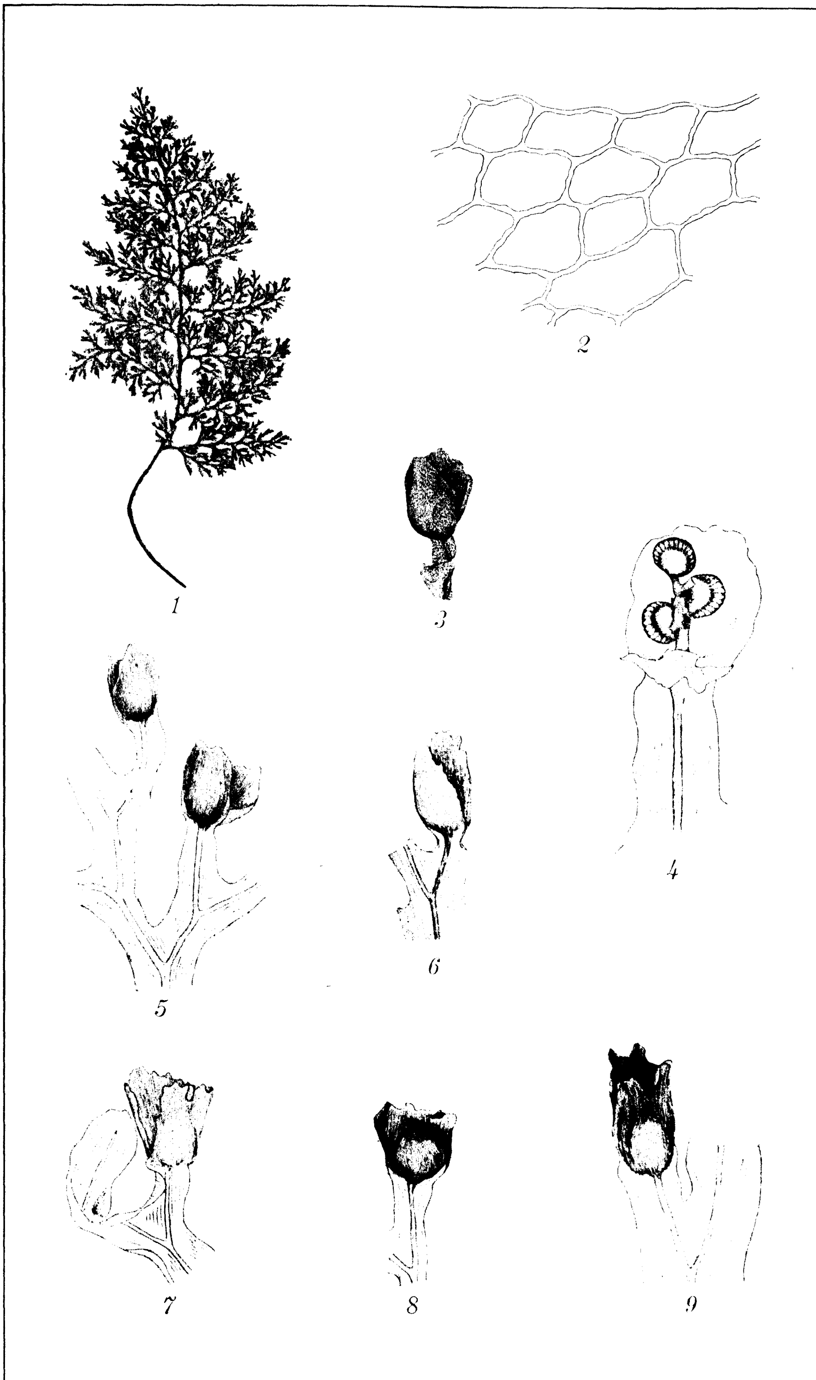

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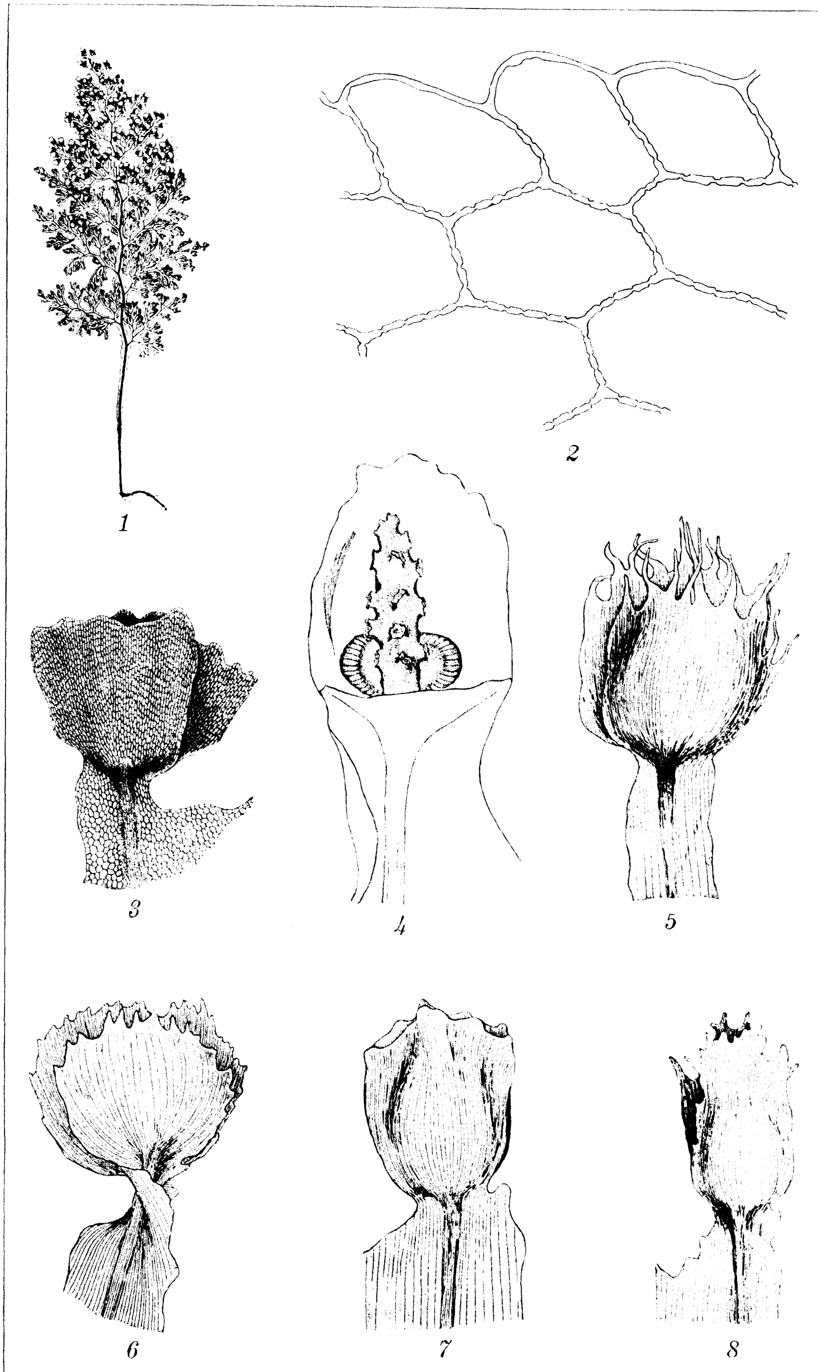

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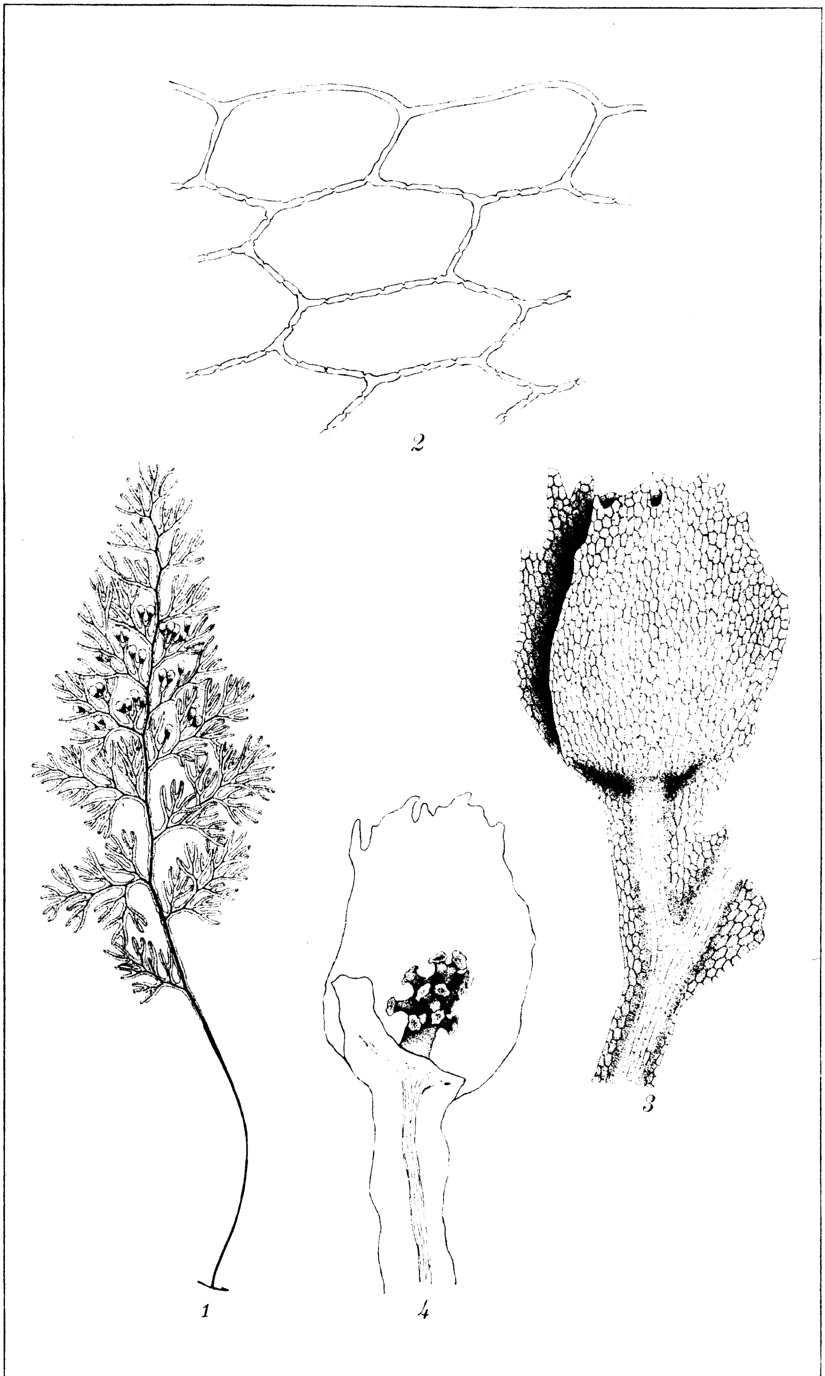

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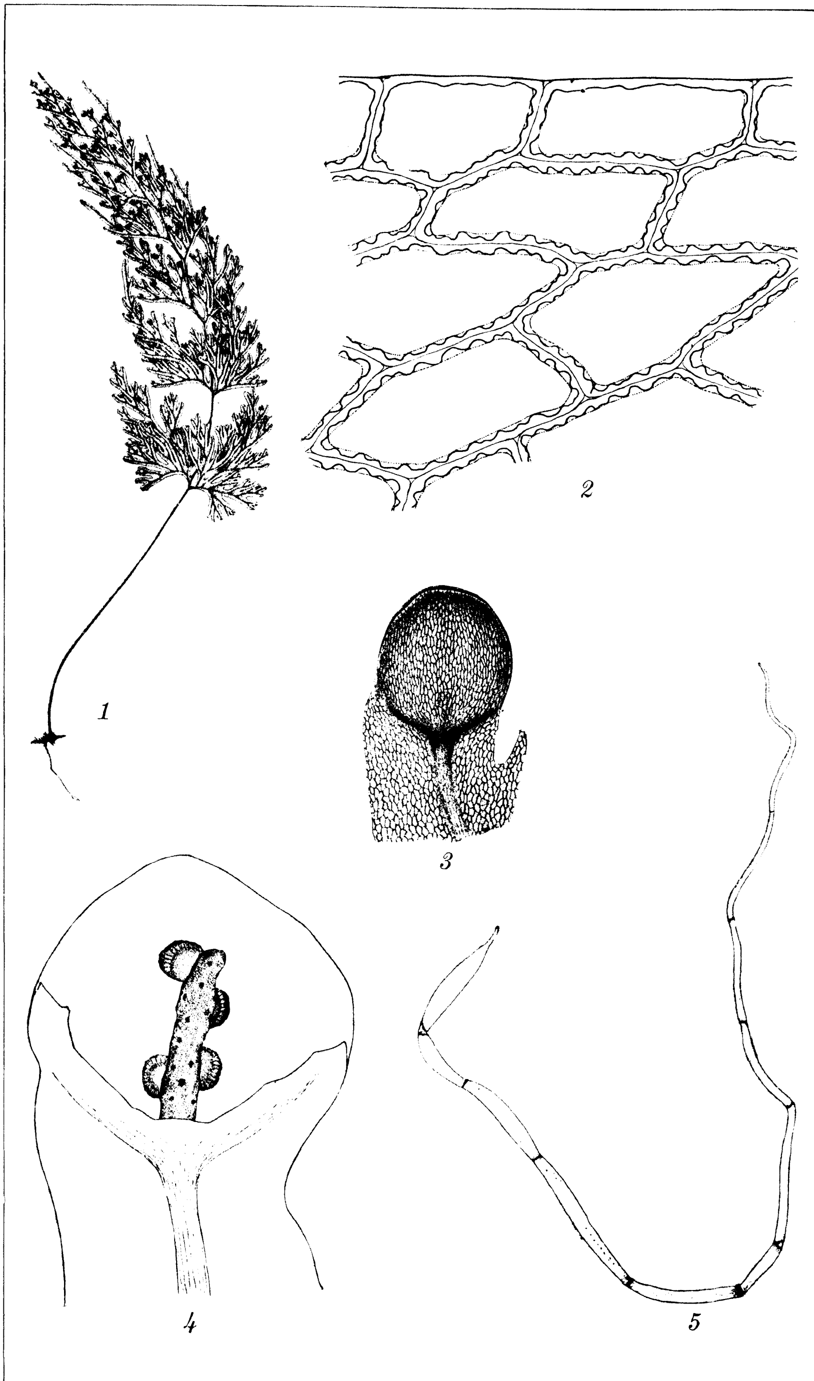

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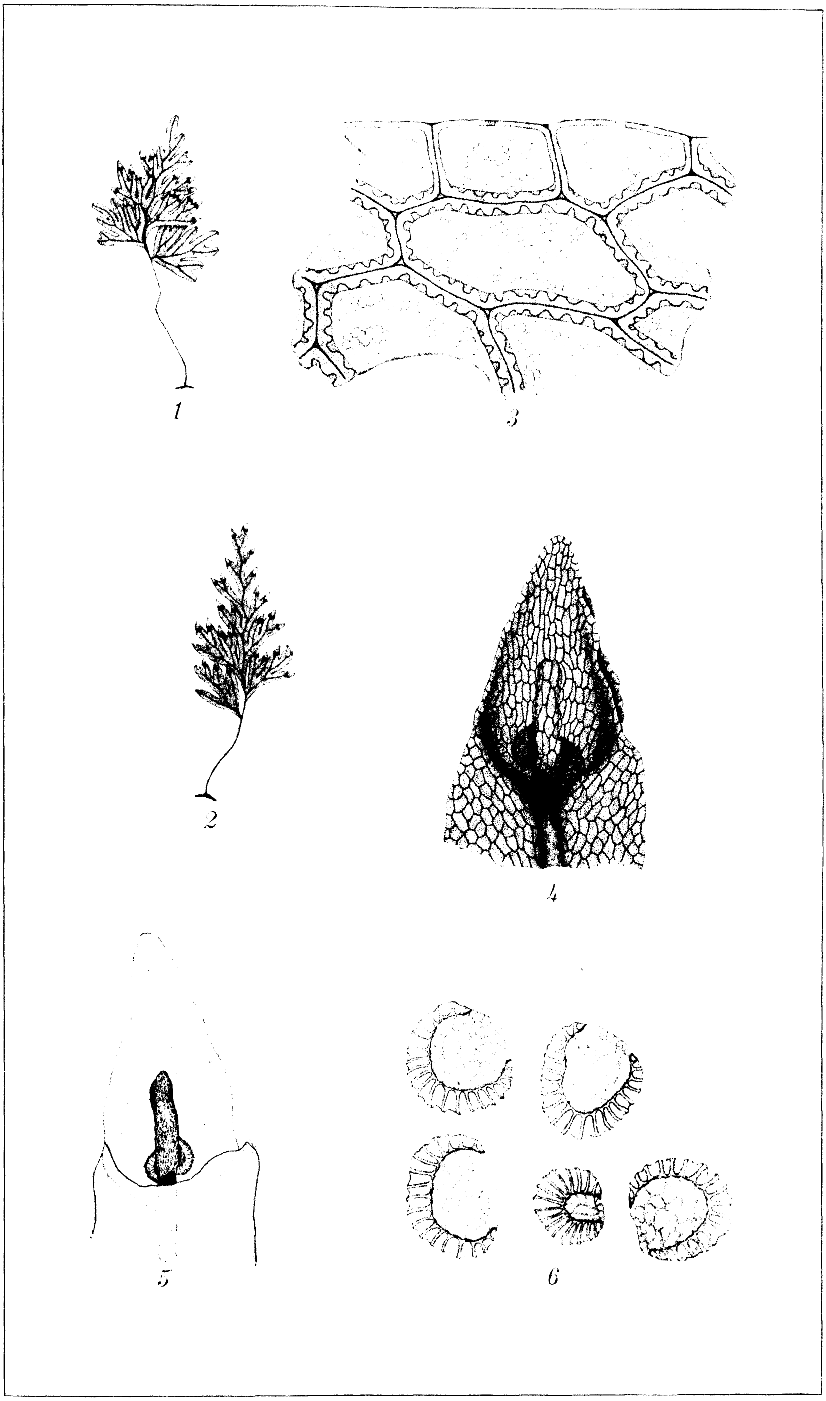

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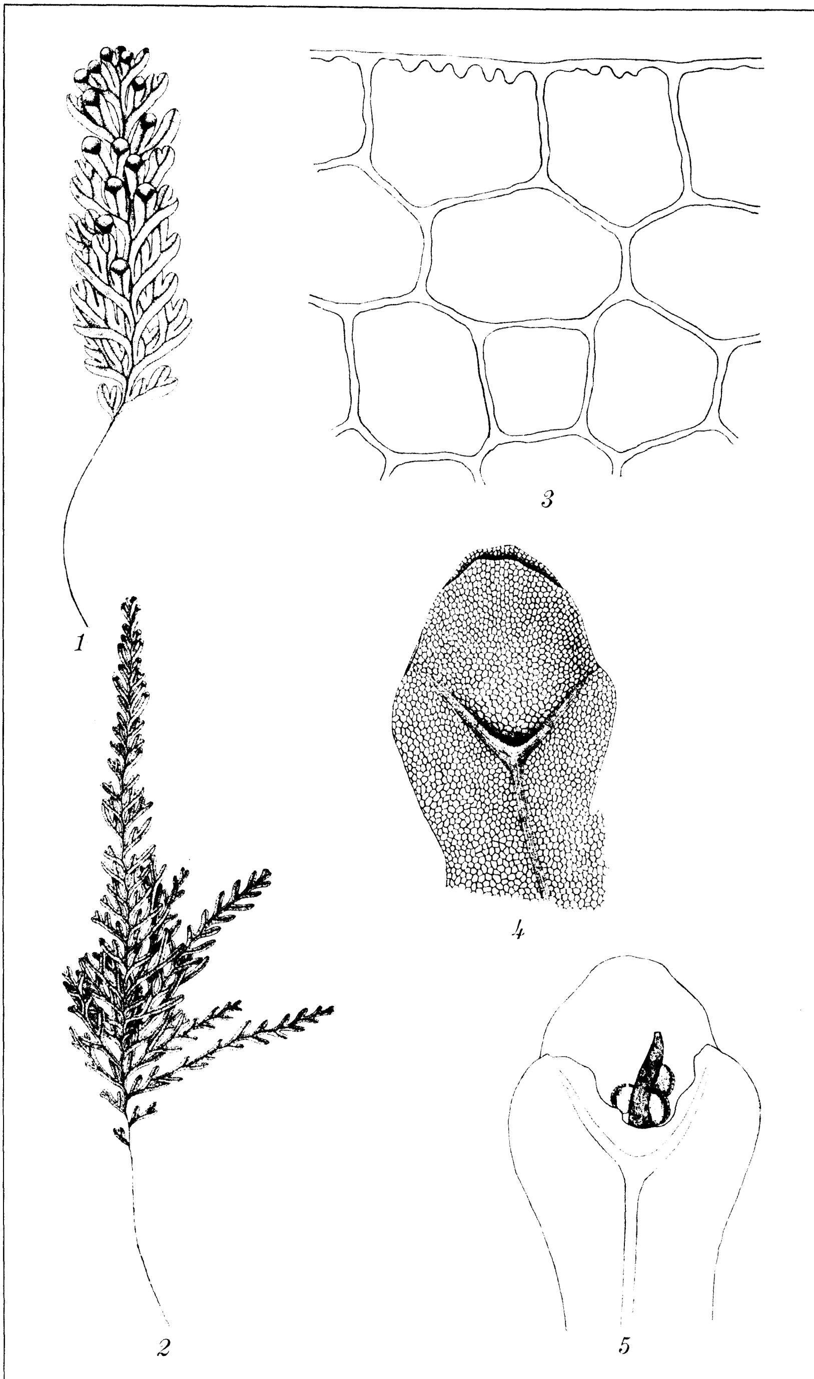

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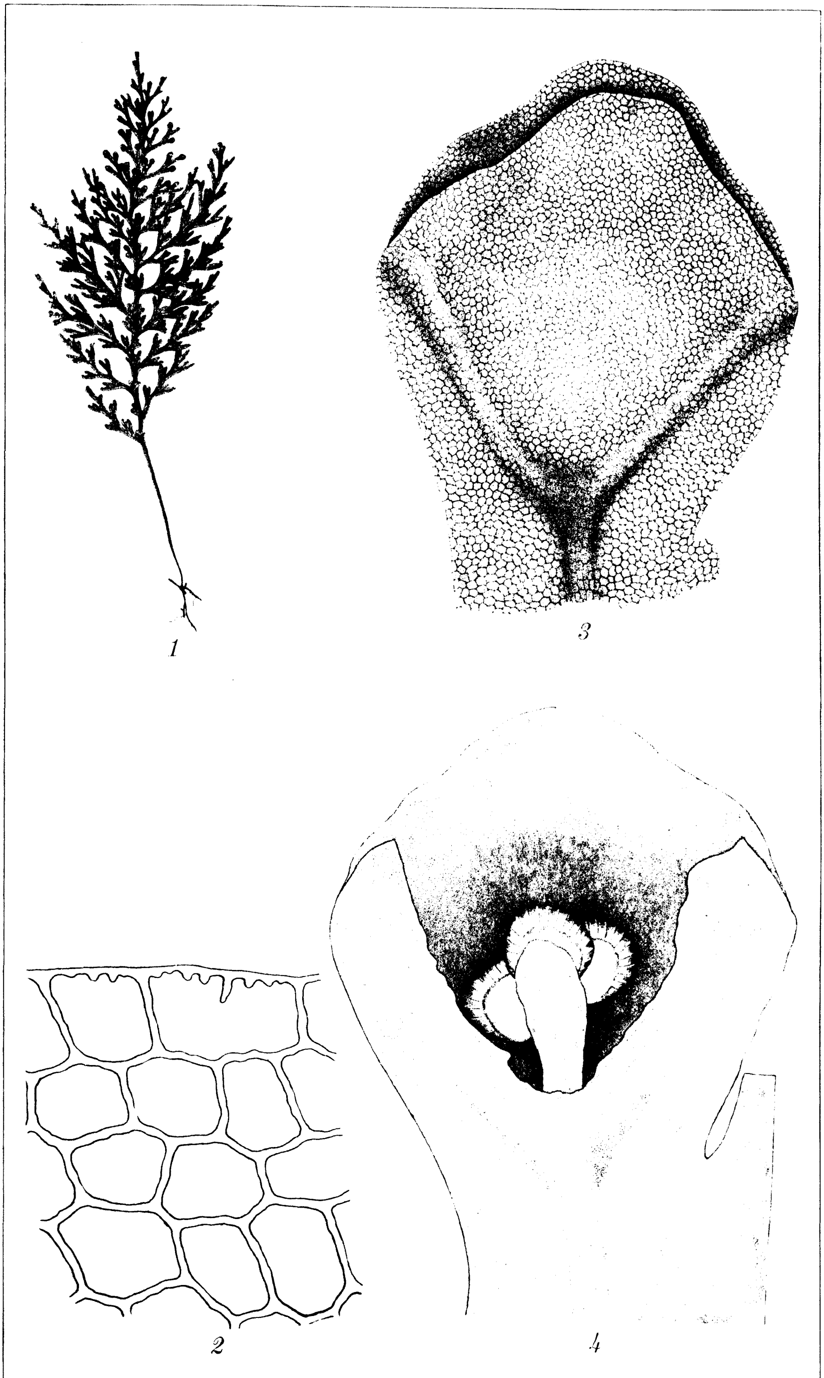

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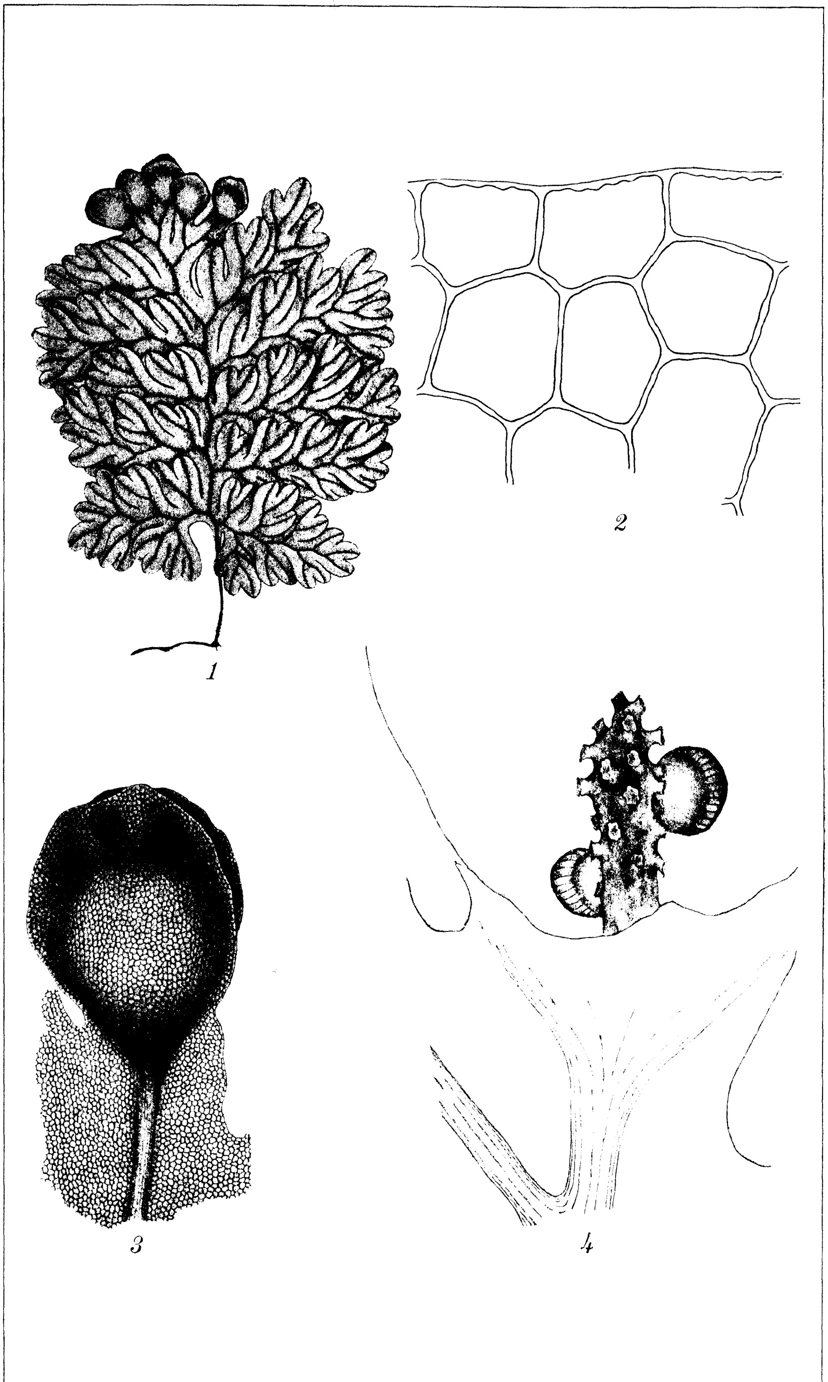

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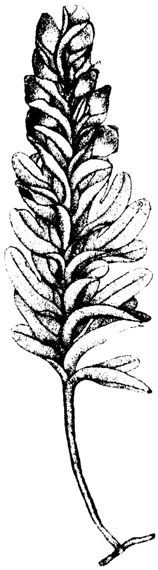

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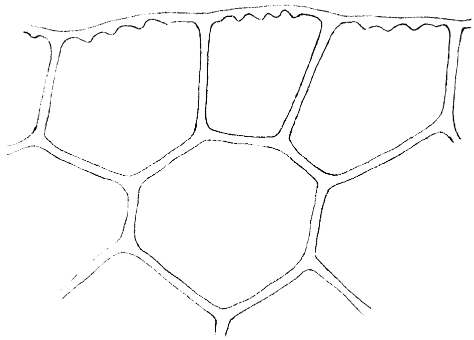

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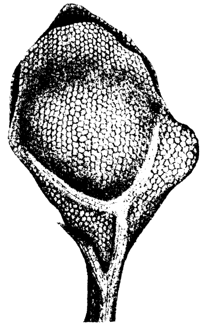

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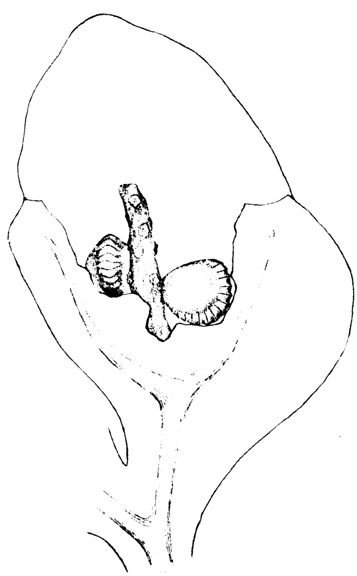

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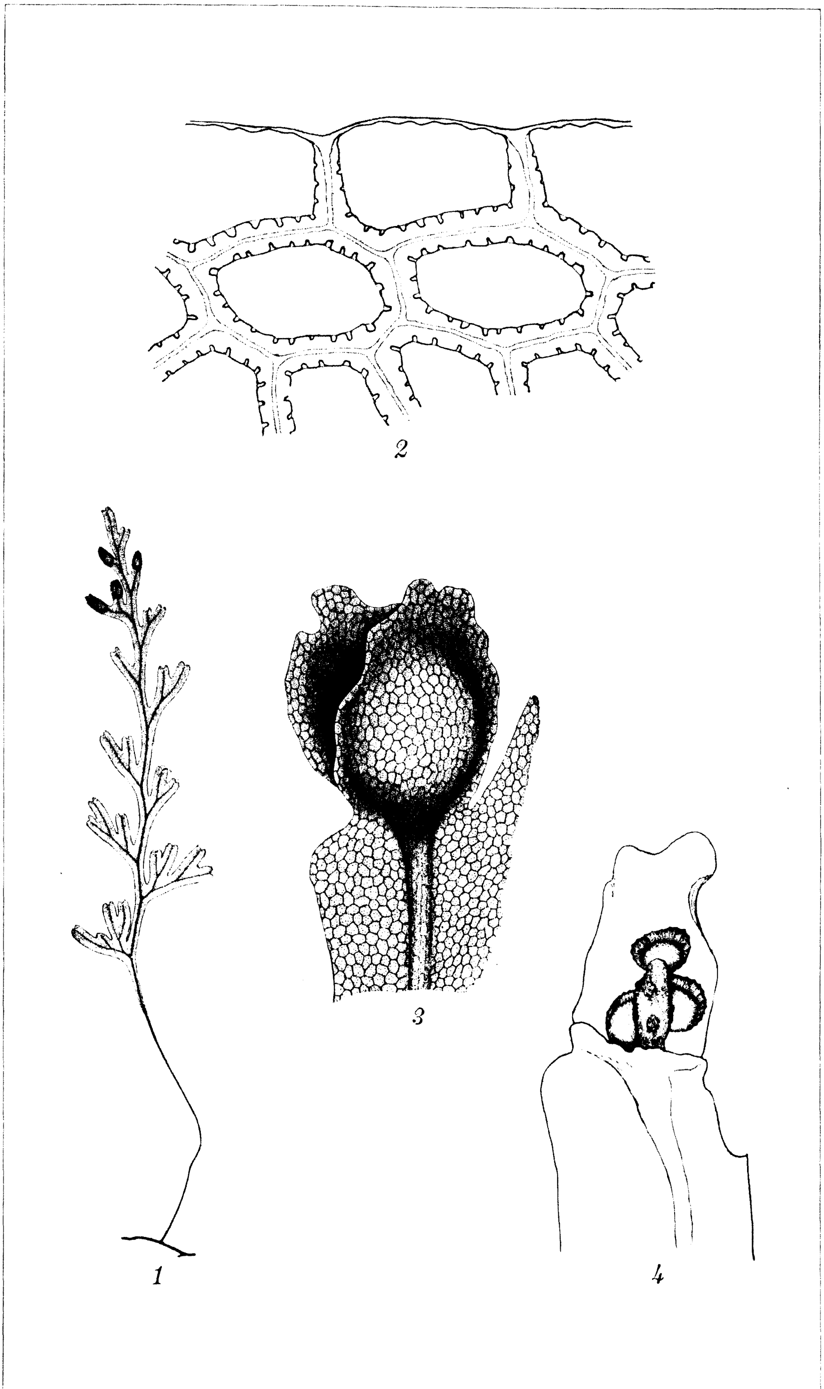

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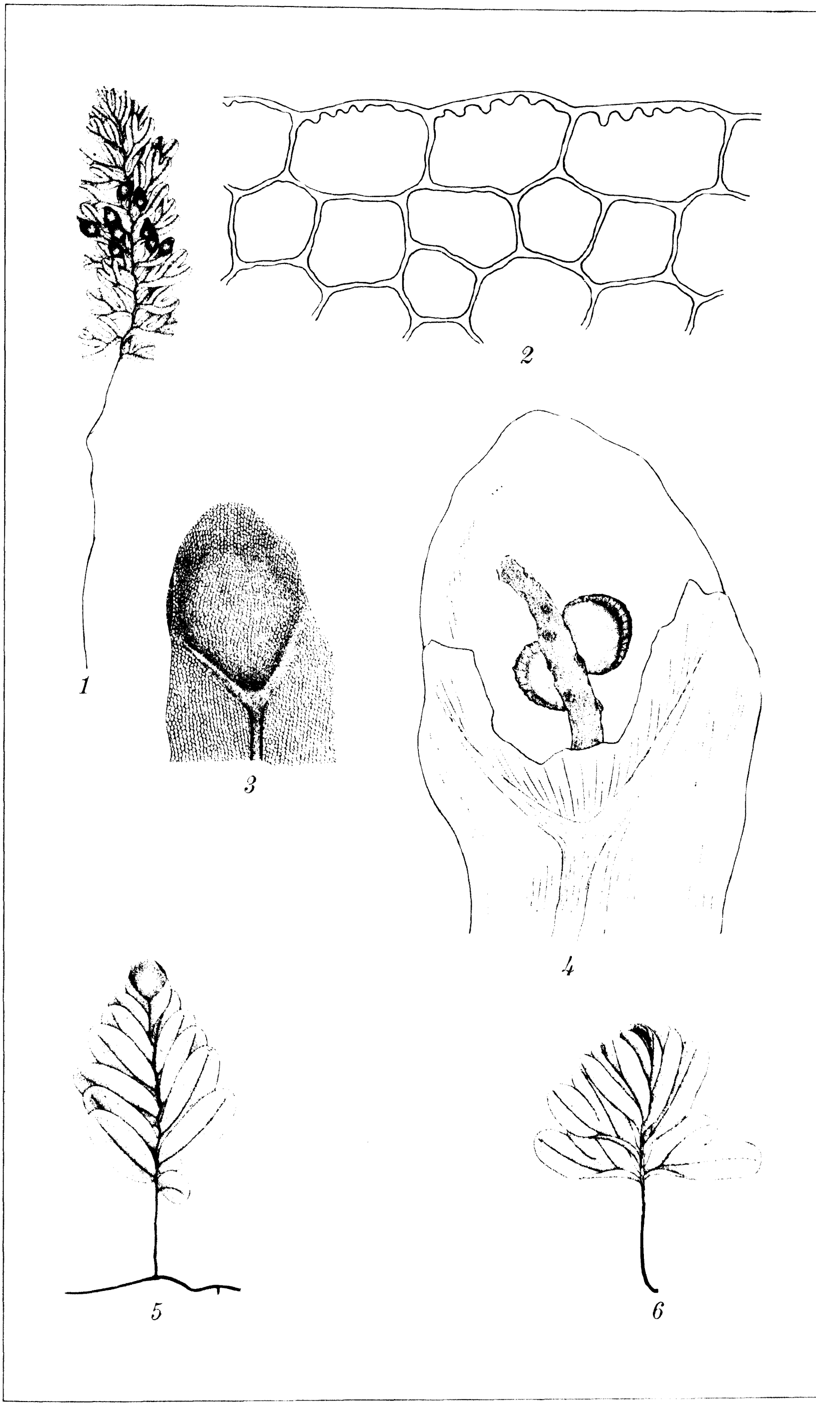

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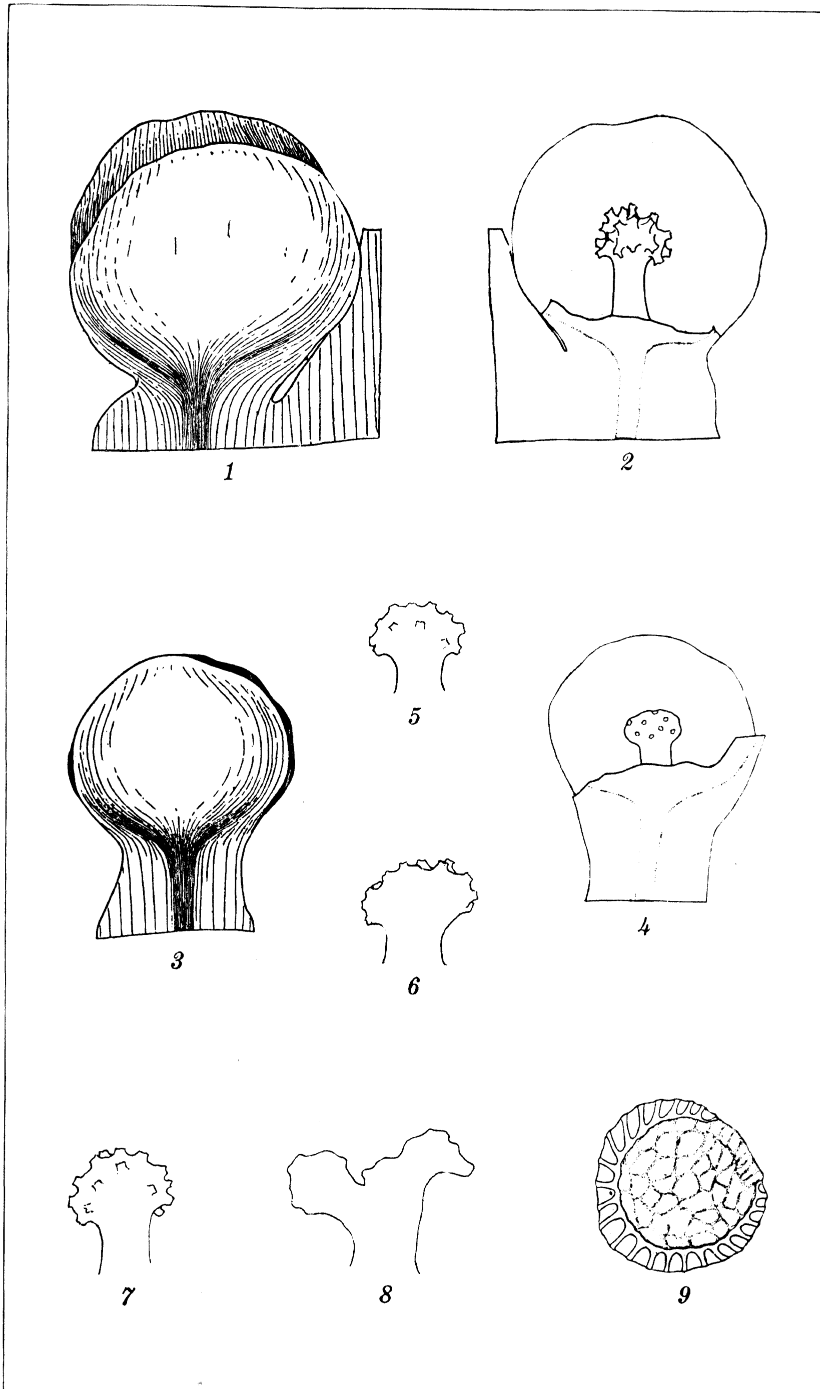

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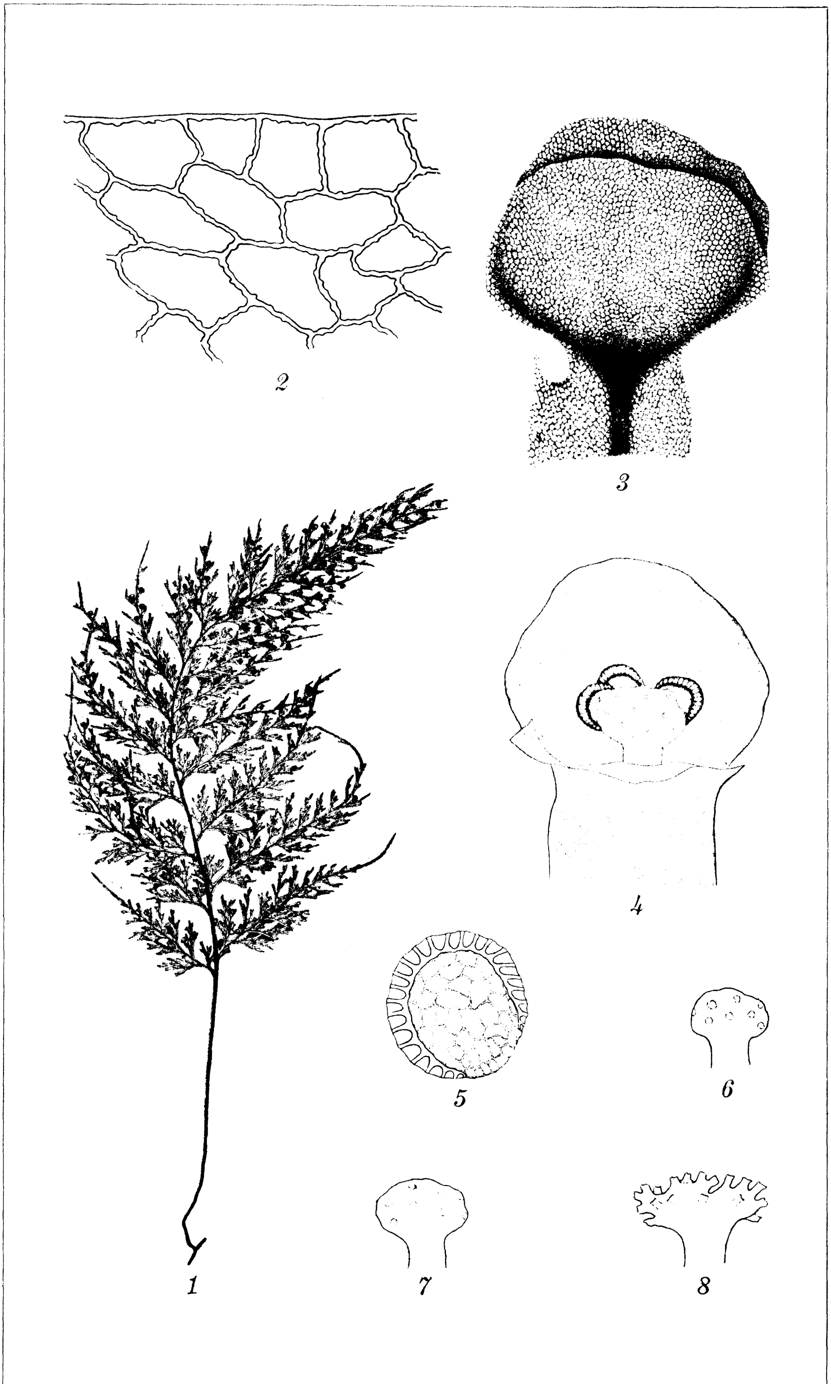

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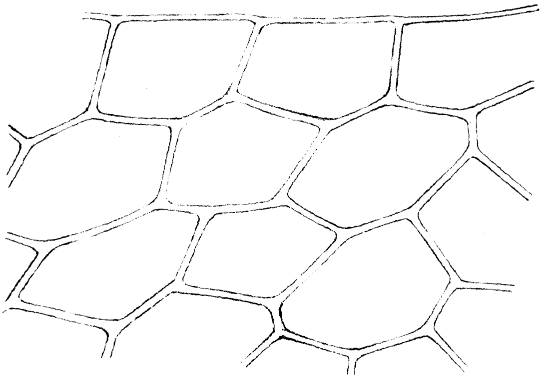

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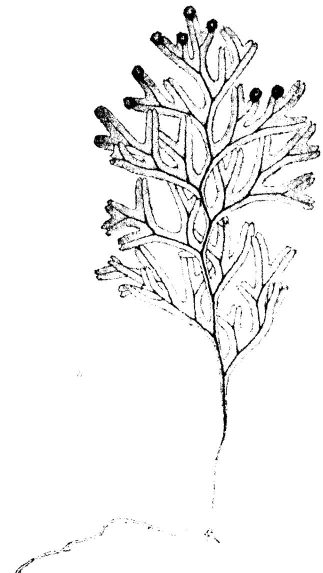

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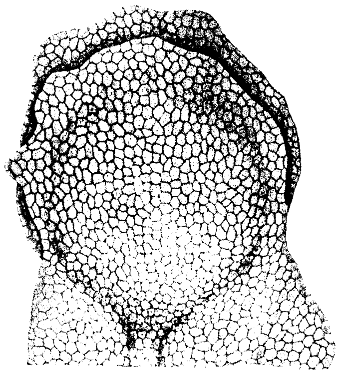

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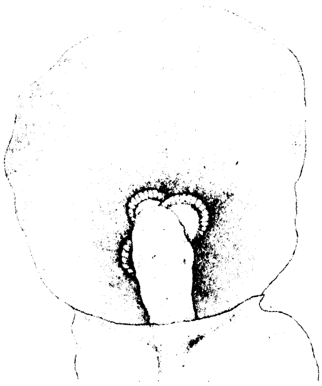

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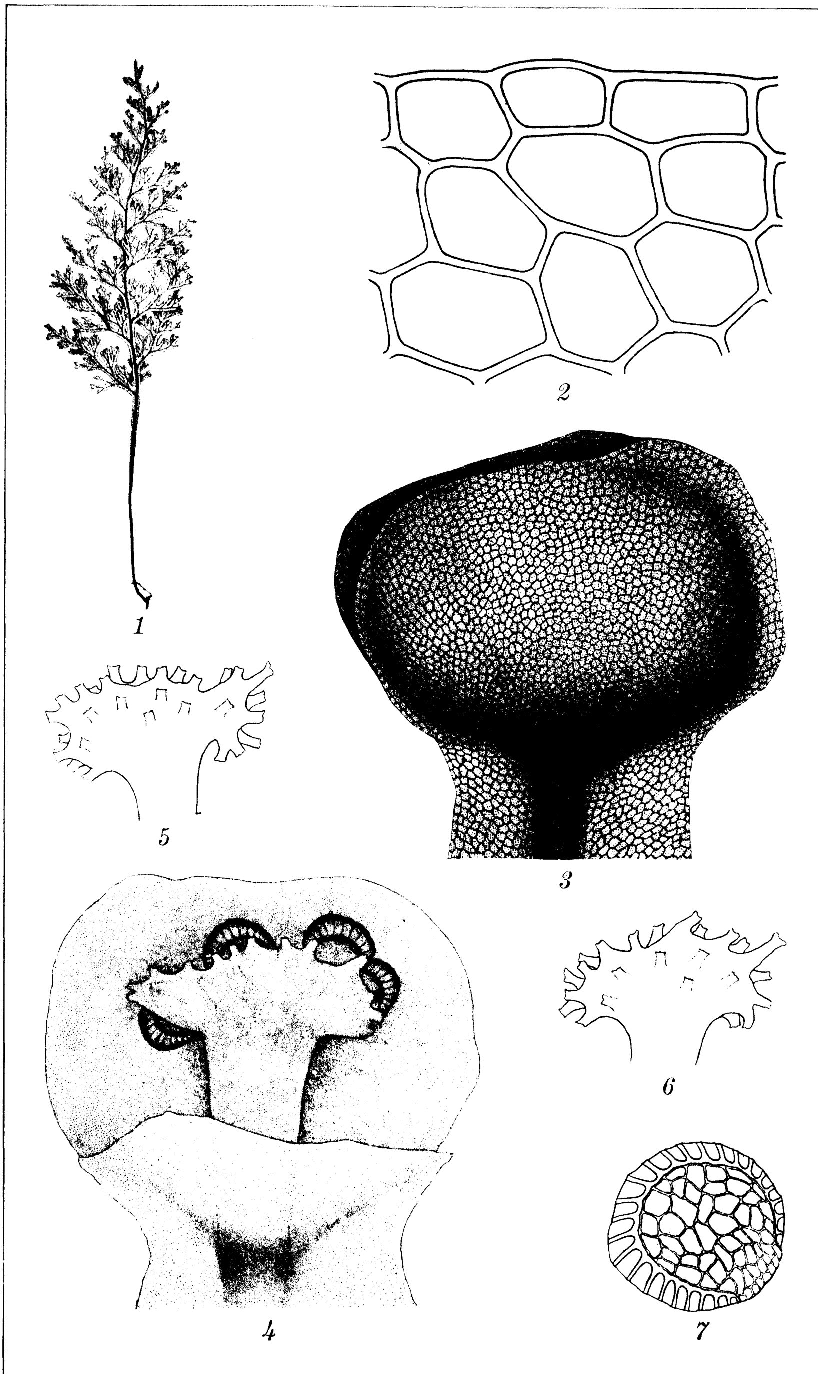

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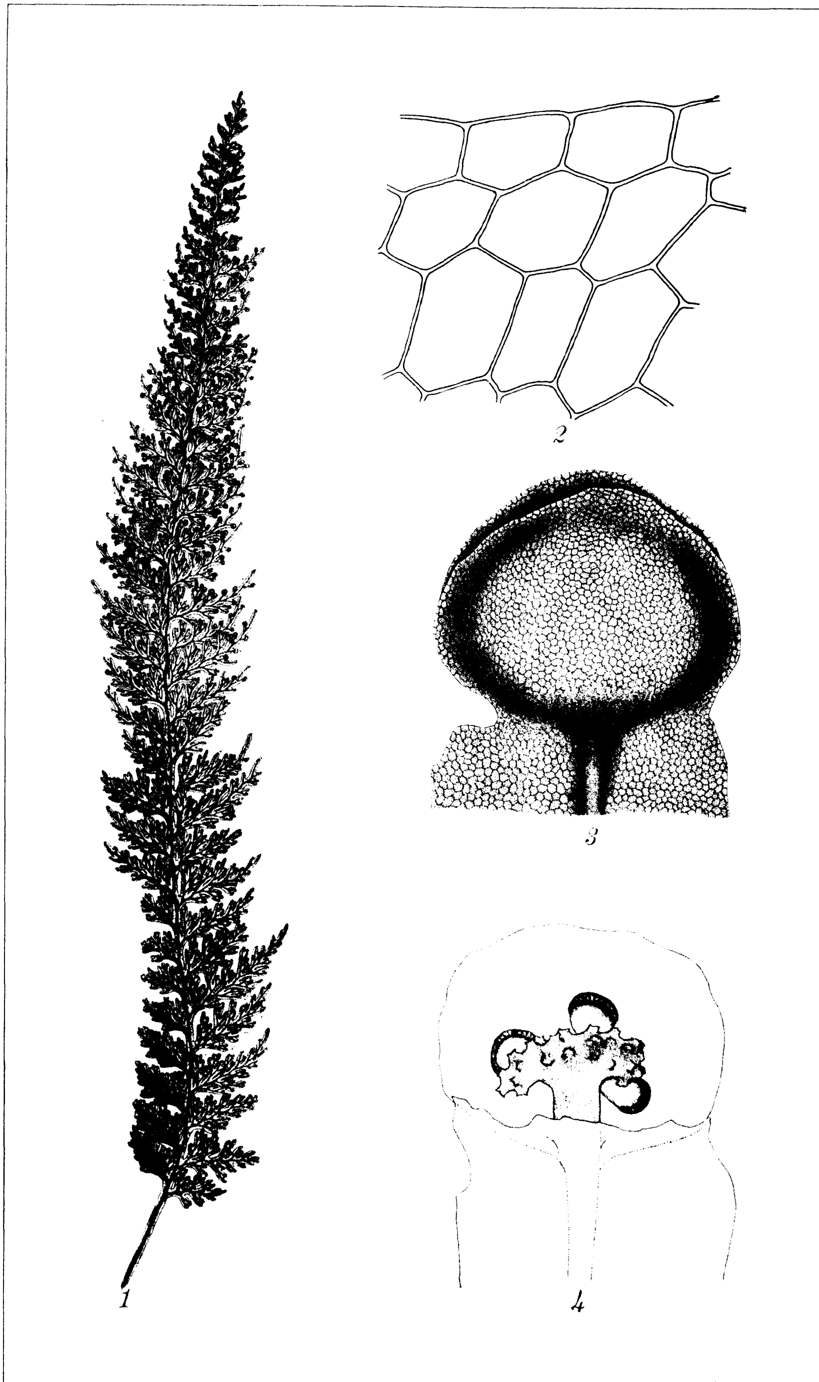

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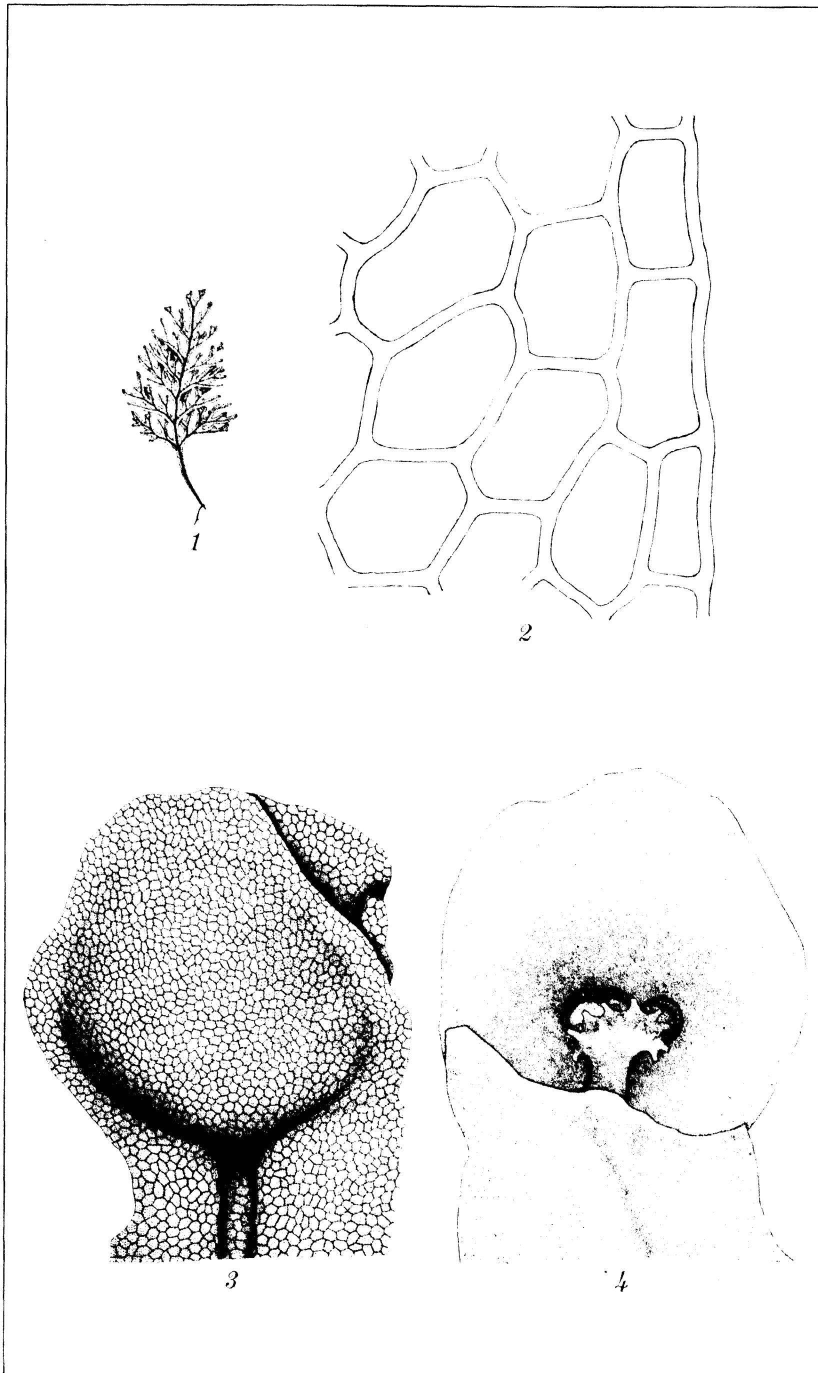

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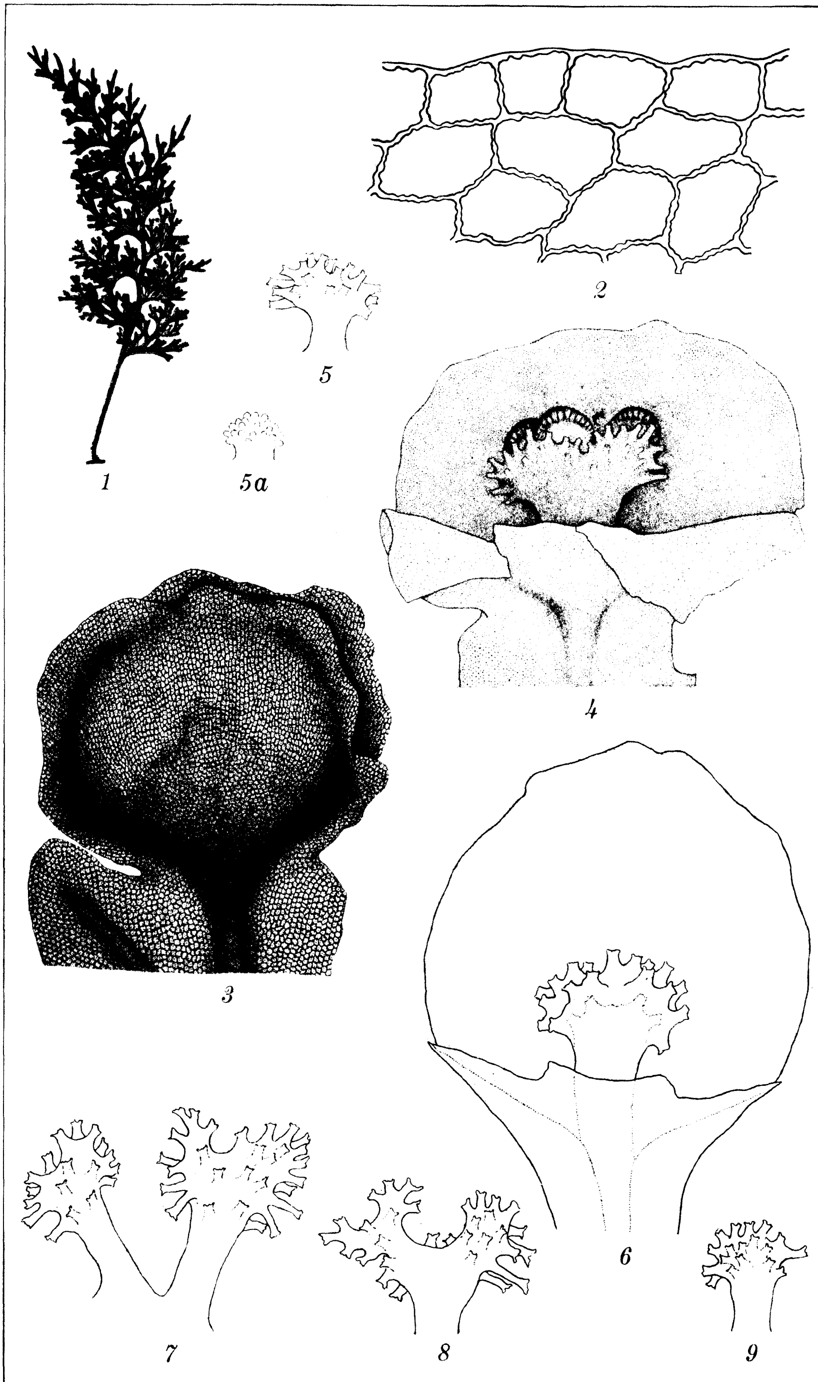

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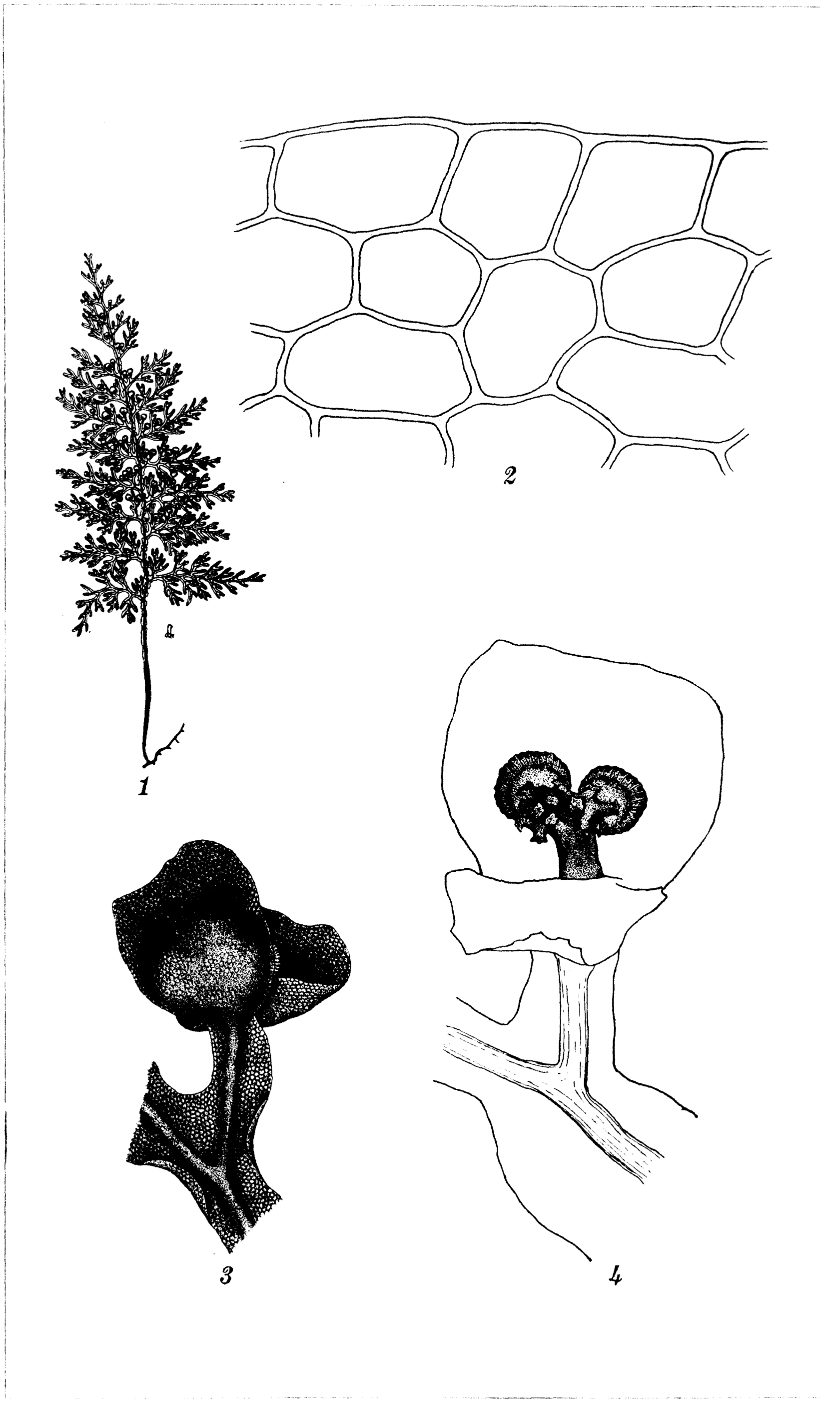

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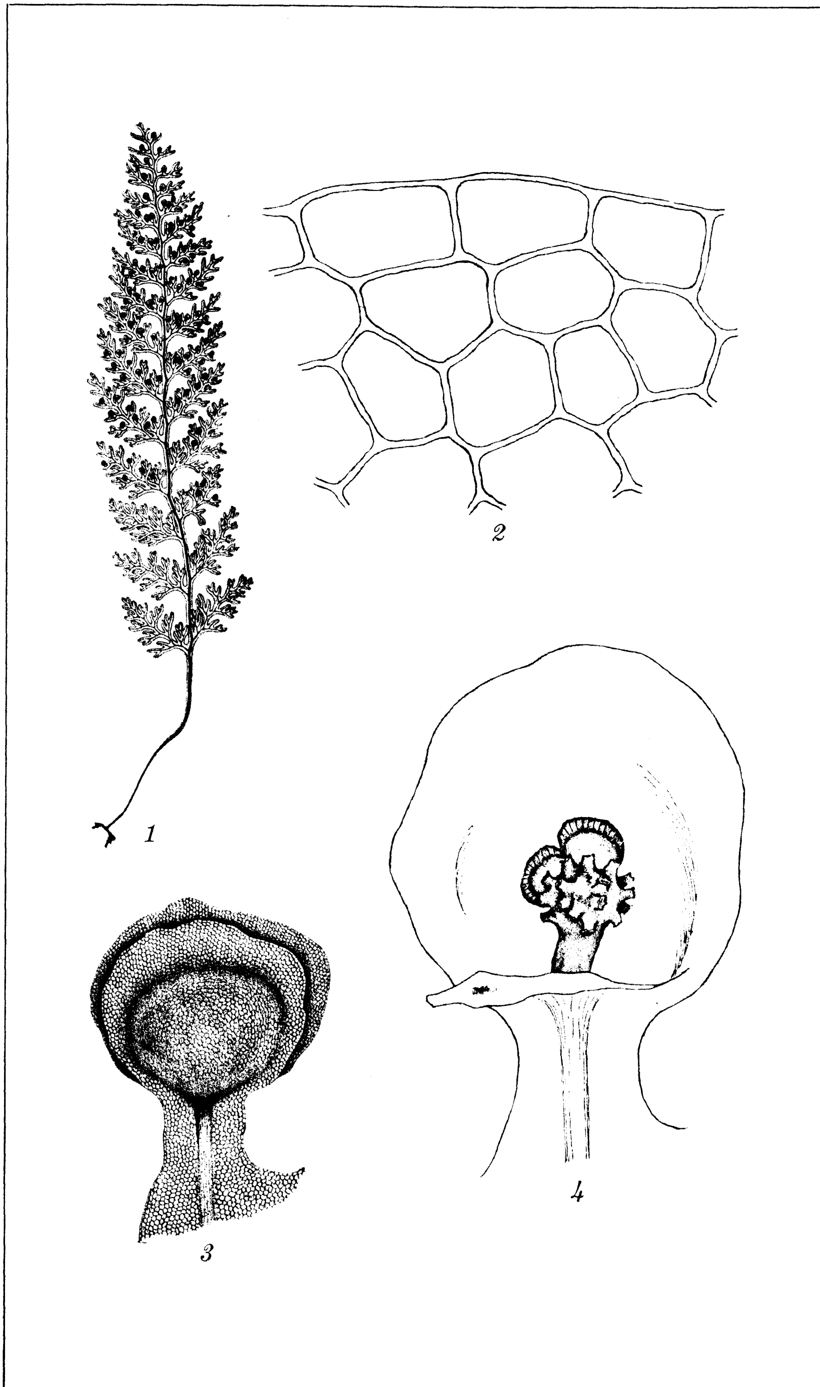

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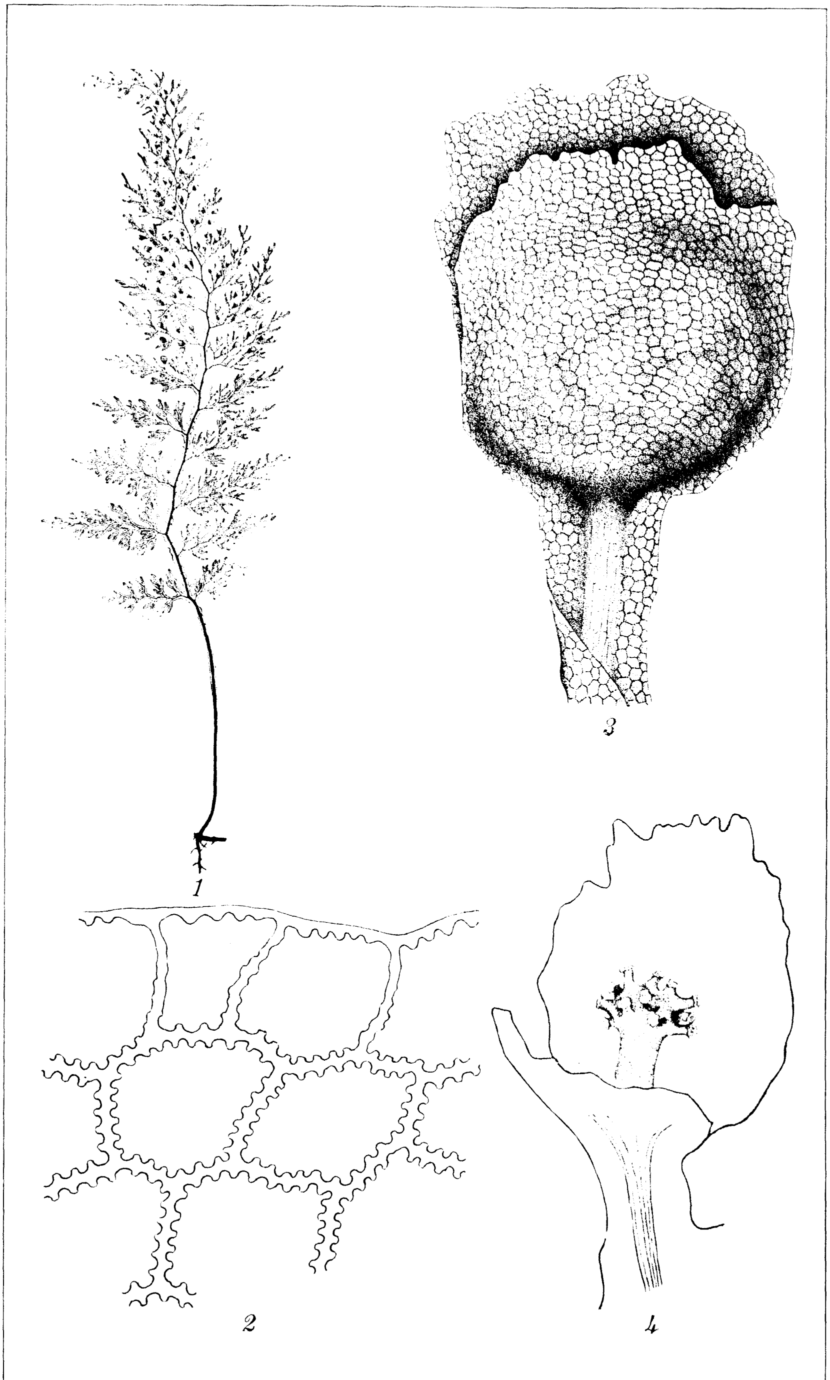

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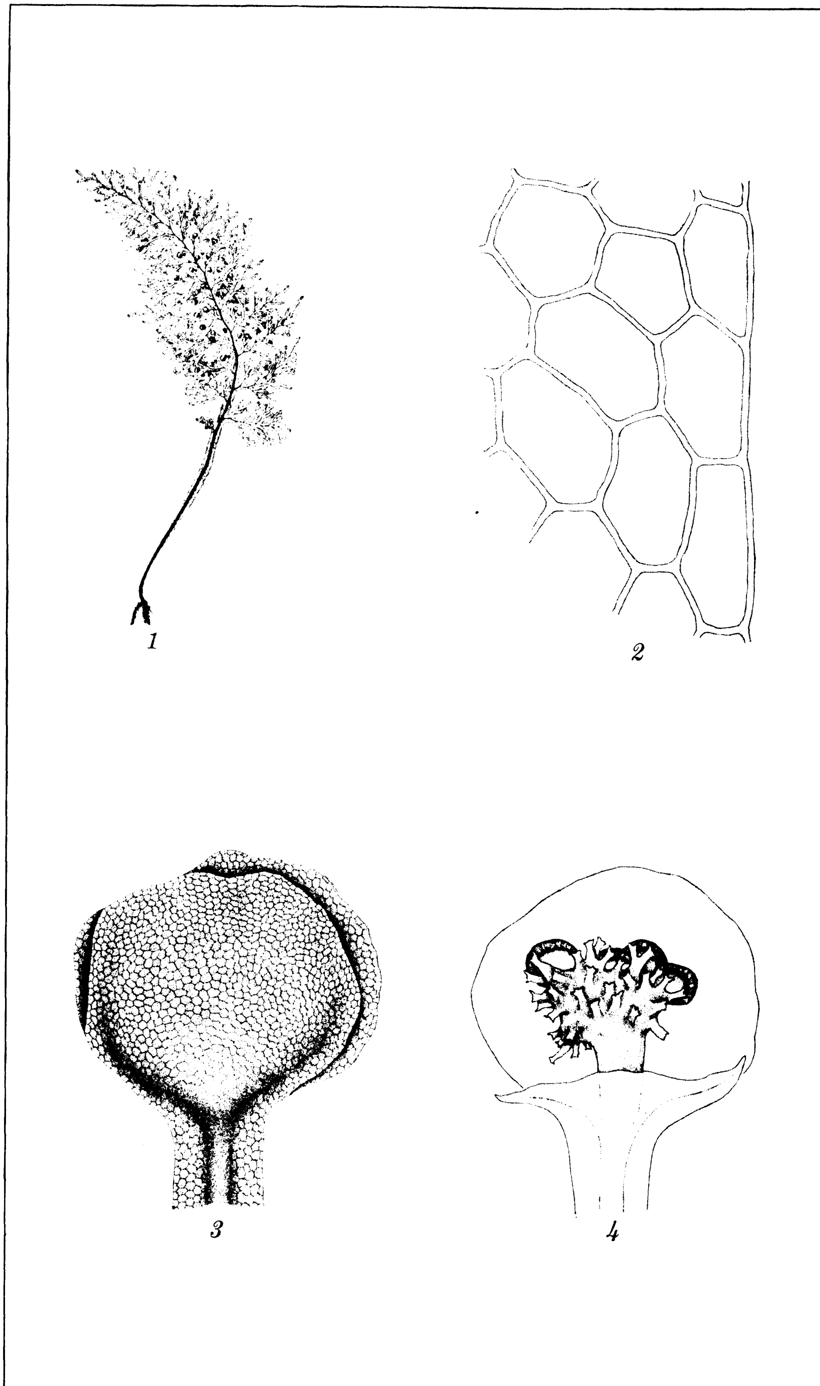

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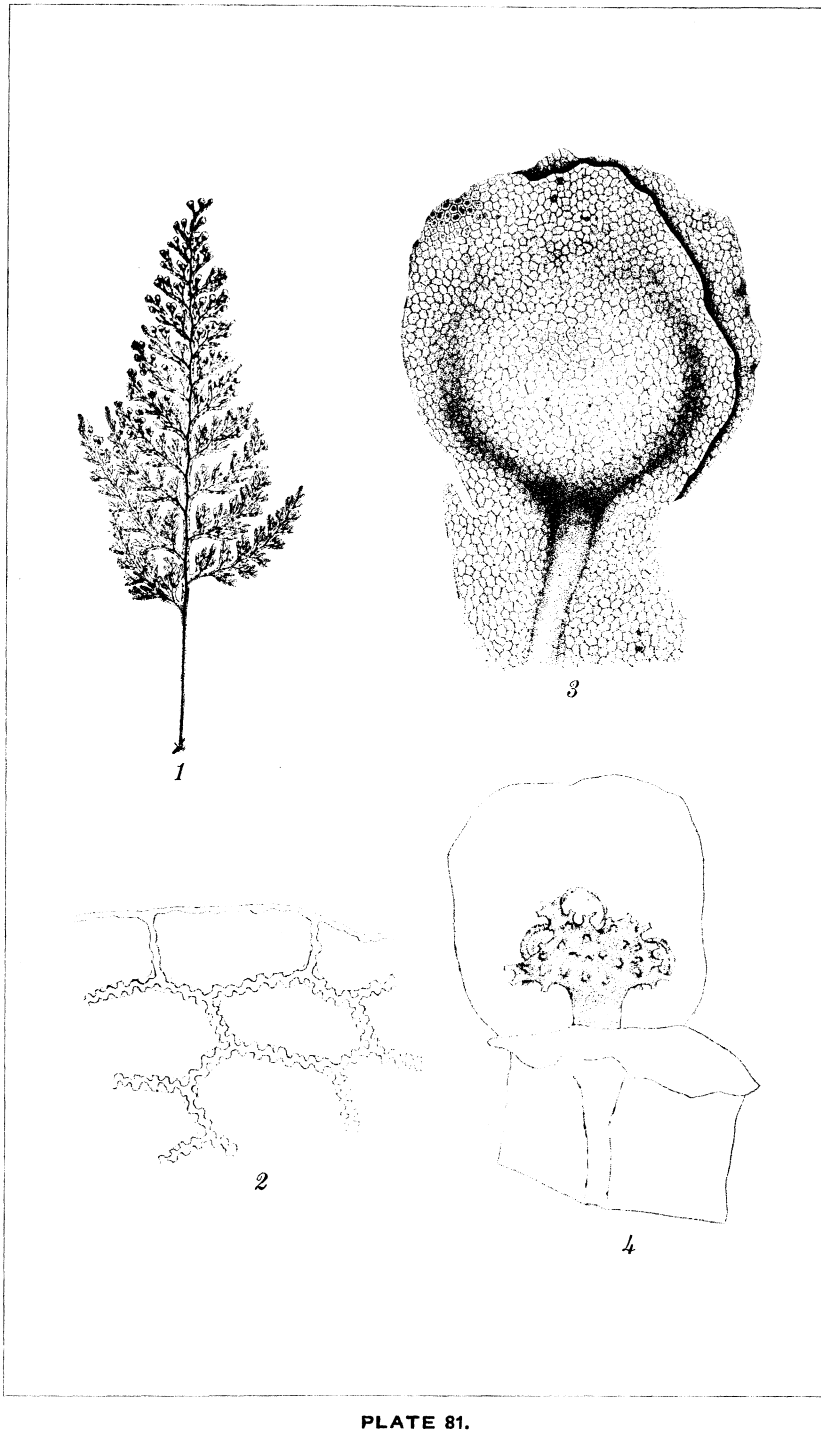

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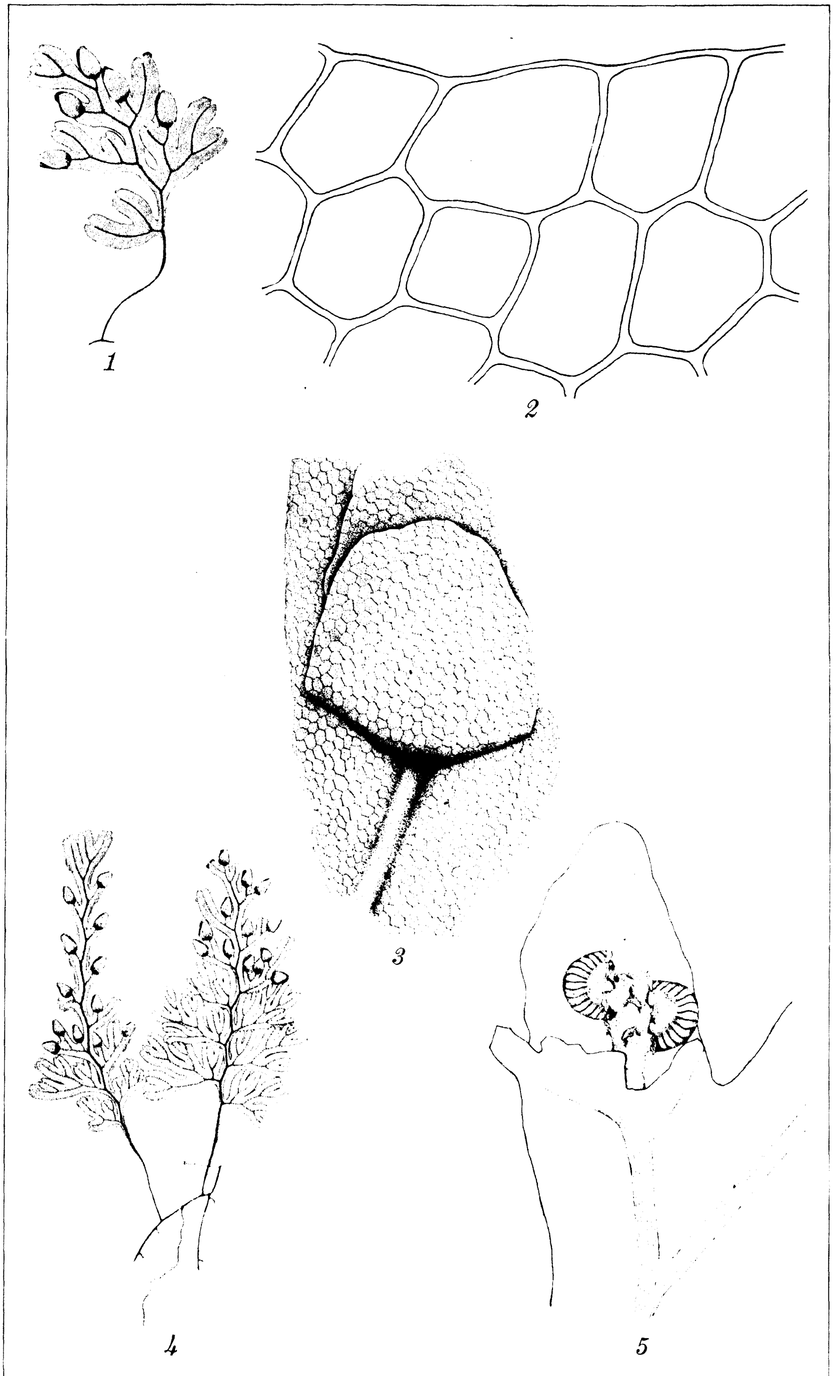

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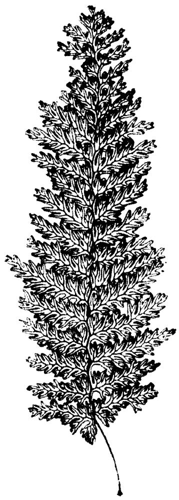

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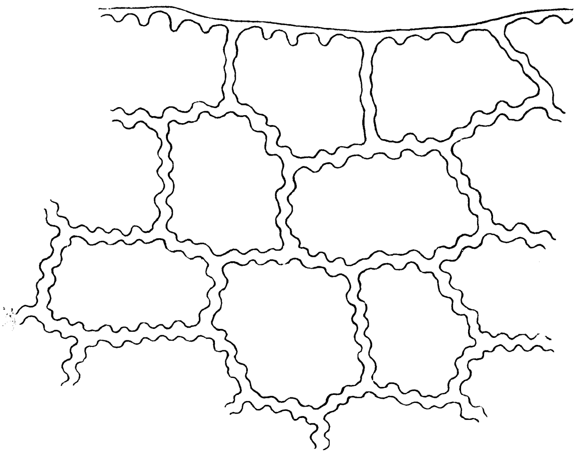

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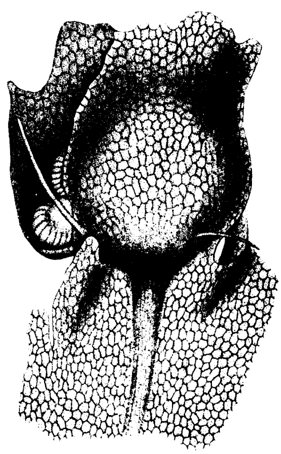

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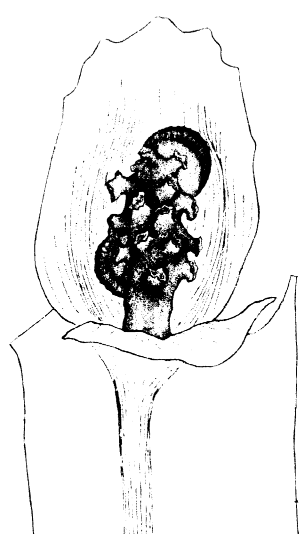

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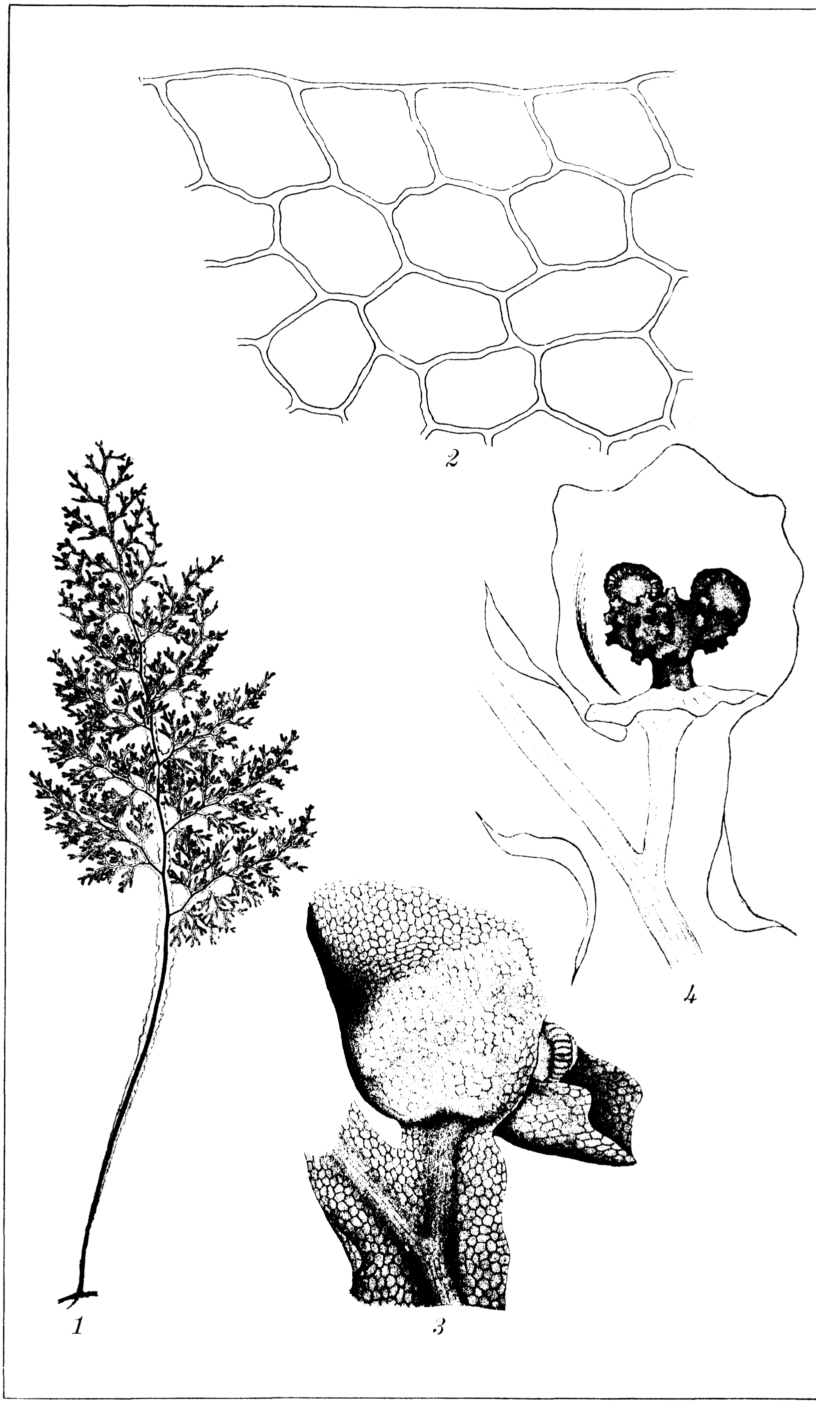

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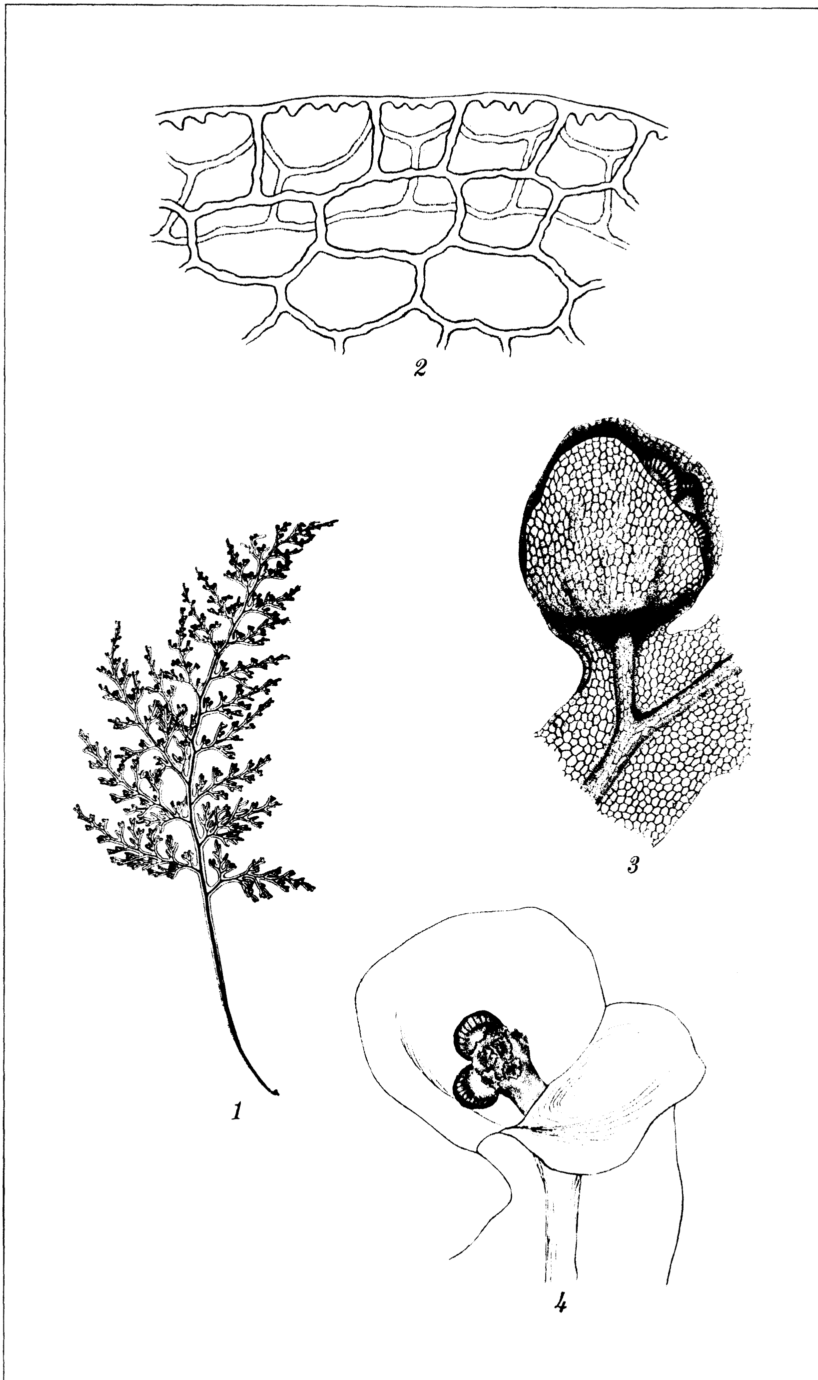

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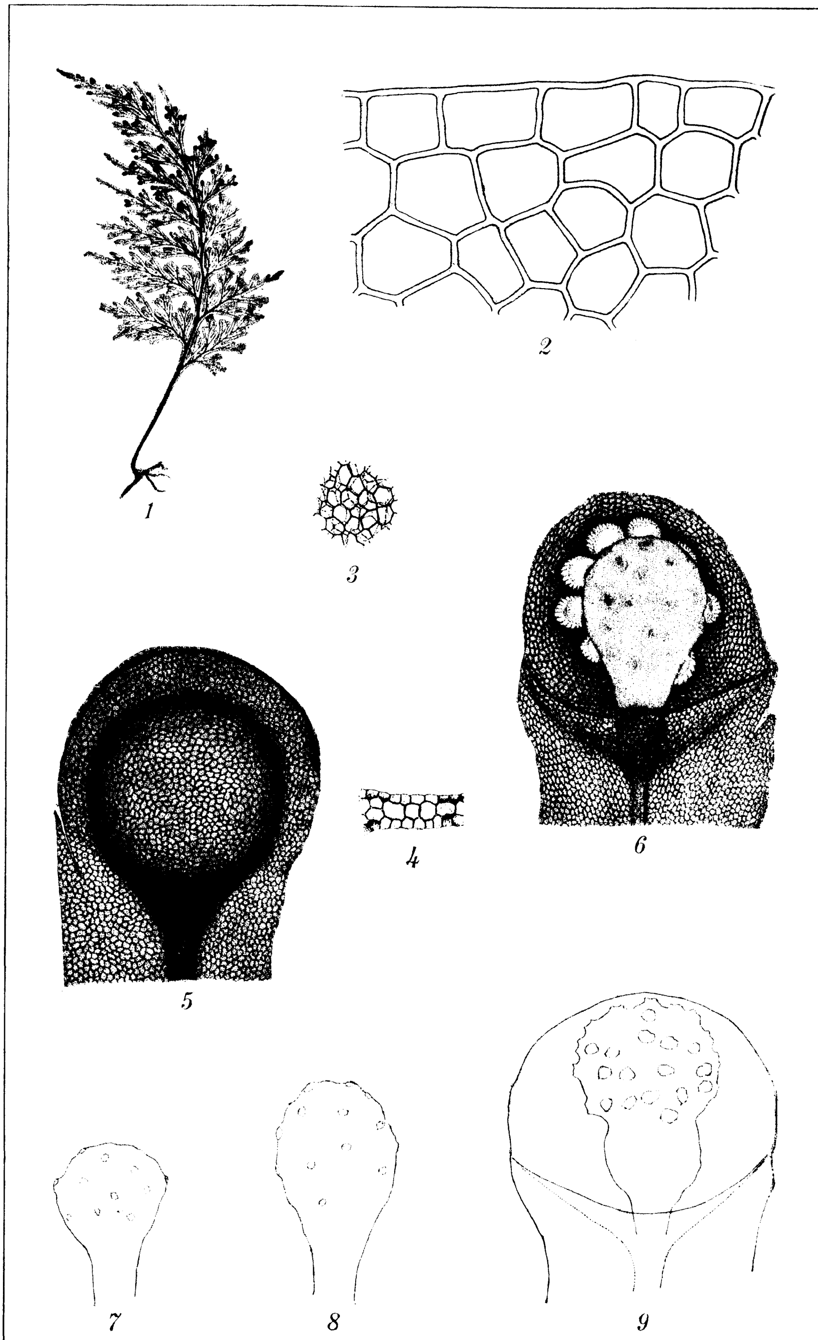
PLATE 86.



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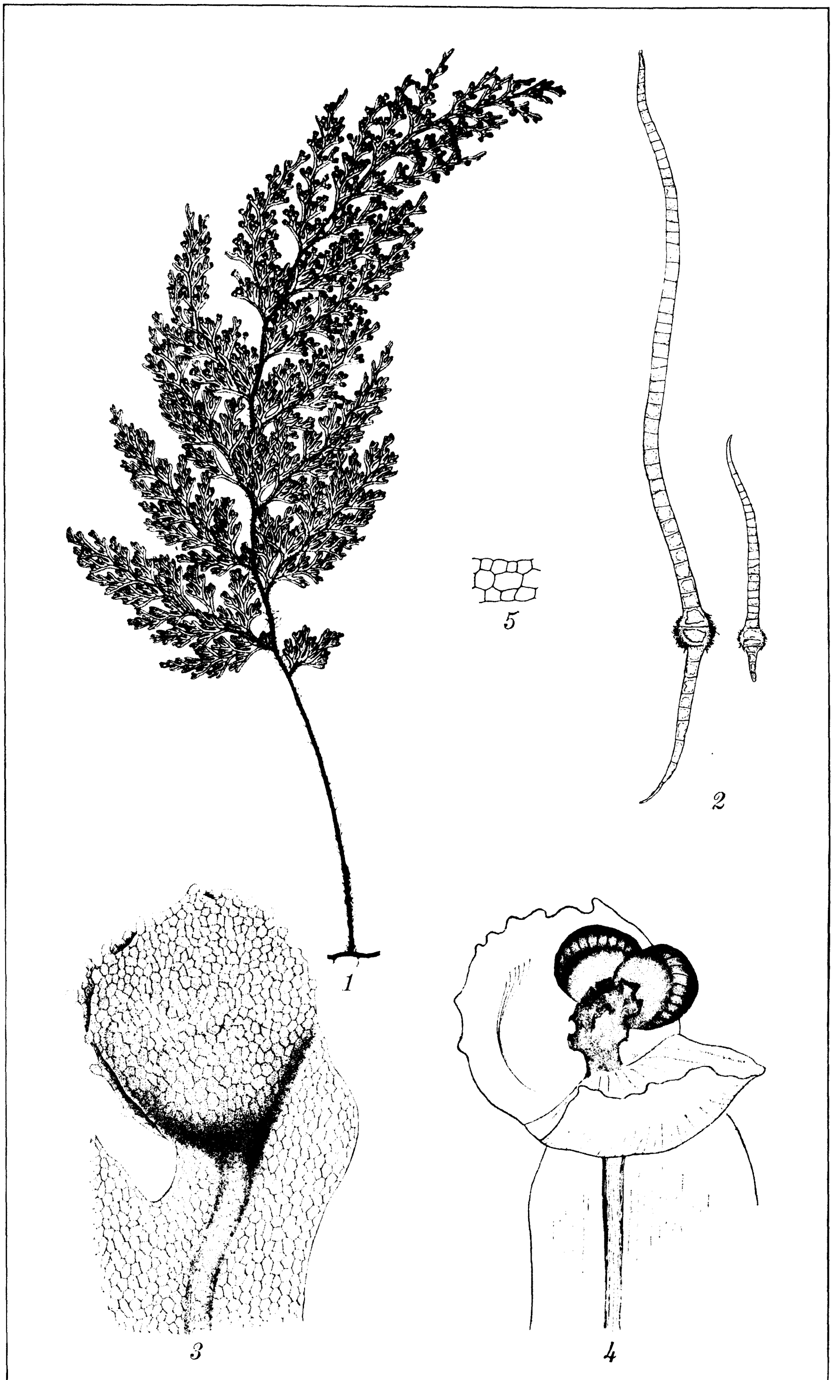

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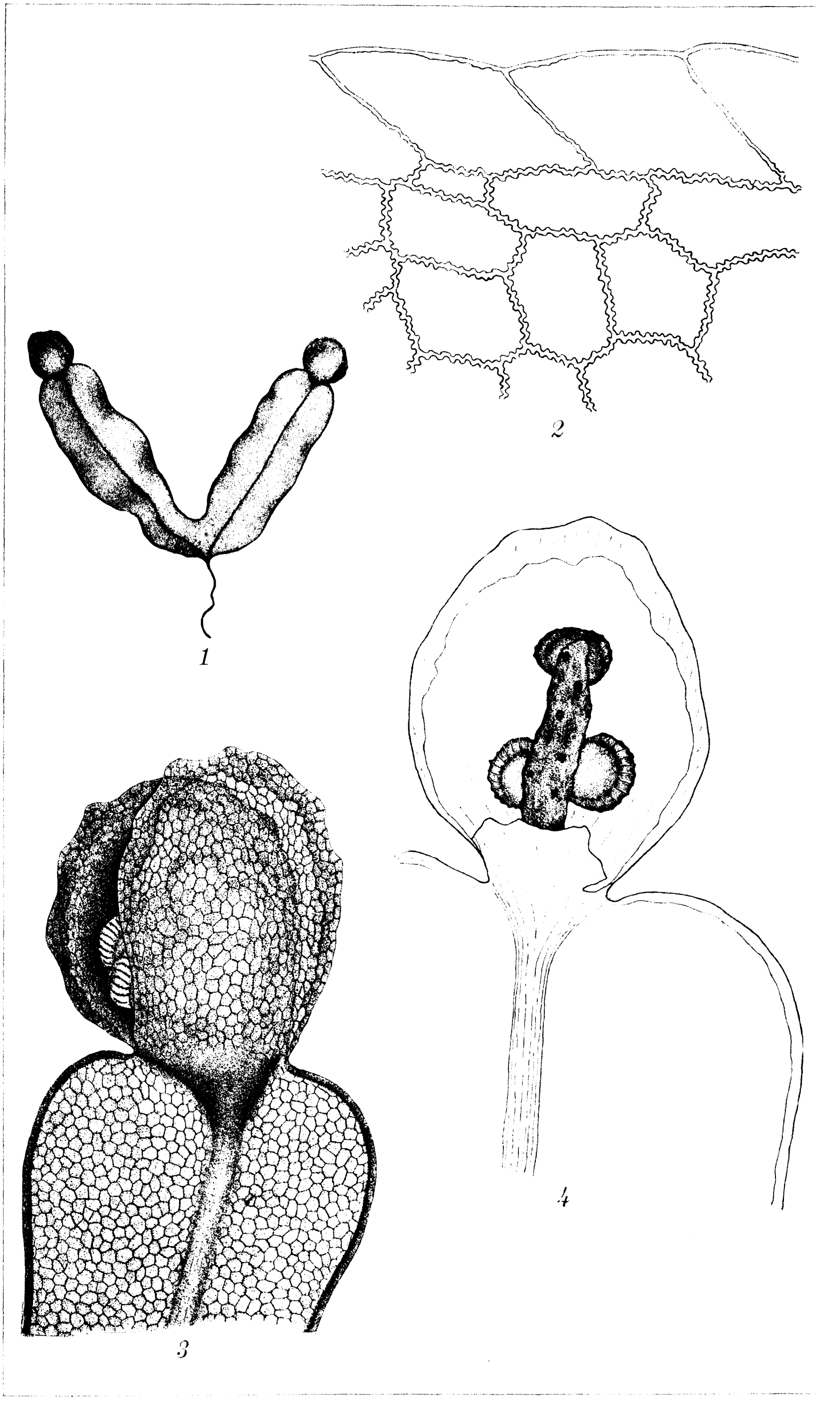

PLATE 89.

THE PHILIPPINE JOURNAL OF SCIENCE

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CHEMICAL ANALYSIS OF SOME PHILIPPINE FORAGE PLANTS

By JOAQUIN MARAÑON and GLORIA LASERNA

Of the Bureau of Science, Manila

In the course of our work on the inorganic constituents of Philippine food plants [1] we received numerous samples of forage crops from the Philippine Bureau of Animal Industry and other government entities. Many of these forage plants were introduced into the Islands during recent years. Cultural characteristics and future possibilities of these forage plants are given in the Fourth Annual Report (1934) of the Bureau of Animal Industry, and in Piper's paper entitled "Forage Crops and Forage Conditions in the Philippines."[2] Several other investigations [3] along this line have also been reported.

Recently we analyzed the numerous samples of forage crops we have received; the results are recorded in this paper.

EXPERIMENTAL PROCEDURE

Representative portions of the plants were first freed from all foreign matter; then the samples were air-dried, powdered, and preserved in well-stoppered bottles.

The samples were analyzed in accordance with the official agricultural methods [4] for common constituents, such as fat, protein, and crude fiber. The results are given in Table 1.

[1] Philip. Journ. Sci. 58 (1935) 317.

[2] Philip. Agri. Rev. 4 (1911) 394.

[3] Philip. Agri. Rev. 13 (1920) 353. Philip. Agri. 15 (1926–27) 547; 18 (1929–30) 125. Philip. Journ. Agri. 3 (1932) 216.

[4] Official and Tentative Methods of Analysis of the Association of Official Agricultural Chemists. 4th ed. (1935).

TABLE 1.—*Approximate chemical composition of Philippine forage plants.*[a]

Name of plant.		Fat.	Protein.	Ash.	Carbohydrates.	
Scientific.	Common.				N-free extract.	Crude fiber.
PASTURE GRASSES		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Coix lachryma jobi Linn.	Adlay	6.10	7.50	3.56	59.32	23.52
Cenchrus viridis Spreng.	Agiñgai	1.27	4.44	9.33	47.61	37.35
Paspalum compressum Nees	Carpet grass	1.43	3.87	2.61	61.12	30.97
Paspalum dilatatum Poir.	Dallis	1.90	5.63	2.46	54.71	35.30
Pennisetum clandestinum Pers.	Kikuyu	1.62	9.19	6.27	54.63	28.29
Tricholaena rosea Nees	Natal red top	2.43	7.47	12.02	46.12	31.93
Pennisetum setosum Rich. (before flowering)		2.36	10.00	11.16	47.58	28.90
Pennisetum setosum Rich. (flowering stage)		1.68	6.59	6.80	45.93	39.00
Pennisetum setosum Rich.		1.92	6.15	10.27	50.73	30.93
Agrostis sp.	Red top	3.32	10.94	3.12	65.73	16.89
Chloris Gayana Kunth. (flowering)	Rhodes grass	1.26	7.20	2.65	51.04	37.85
Chloris Gayana Kunth.	do	1.72	7.00	4.40	52.83	34.05
Andropogon contortus Linn.	Silat-silatan	1.45	5.72	10.14	42.63	40.06
Themeda triandra Forsk. (flowering stage)	Silibon grass	2.46	5.88	1.34	53.21	37.11
Melinis minutiflora Beauv.	Yaragua grass	2.08	8.94	2.49	49.20	37.29
SILAGE CROPS						
Elephantopus scaber Linn.	Dila-dila	4.75	8.25	15.89	46.47	24.64
Ipomoea triloba Linn.	Halobagbug	3.06	12.50	10.41	43.26	30.77
Panicum frumentaceum Salisb. (fruiting)	Japanese millet	2.41	11.38	9.75	54.43	22.03
Holcus sp. (flowering)	Milo maiz	1.90	11.25	11.60	45.53	29.72
Holcus sp. (fruiting)	do	2.69	7.31	2.15	54.72	33.13
Pennisetum purpureum Schum. (before flowering)	Napier grass	1.54	5.82	7.40	54.32	30.92
Holcus sudanensis Bailey (before flowering)	Sudan grass	2.90	10.68	11.27	42.61	32.60

Holcus sudanensis Bailey (flowering)	do	2.37	10.31	10.48	46.24	30.60
Euchlaena mexicana Schrad.	Teosinte	1.95	5.94	6.76	54.50	30.85
Saccharum sp. (before flowering)	Uba cane	2.29	5.38	4.87	54.50	32.96
LEGUMES						
Glycine hispida Maxim.	Soy-bean hay	2.73	14.38	6.40	35.75	40.74
Phaseolus calcaratus Roxb.	Tapilan-bean hay	1.70	9.00	8.07	34.36	46.87
Stizolobium deeringianum Bort.	Velvet-bean hay	3.26	18.94	6.98	52.29	18.53

[a] Percentages based on moisture-free samples.

TABLE 2.—*Phosphorus, calcium, and iron contents of some Philippine plants.*

Name of plant.		Lime (CaO) in—		Phosphorus (P_2O_5) in—		Iron (Fe_2O_3) in—	
Scientific.	Common.	Ash.	Moisture-free samples.	Ash.	Moisture-free samples.	Ash.	Moisture-free samples.
PASTURE GRASSES		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Coix lachryma jobi Linn.	Adlay	2.11	0.08	34.39	1.22	0.28	0.01
Cenchrus viridis Spreng.	Agiñgai	1.94	0.18	8.14	0.76	0.06	0.006
Paspalum compressum Nees.	Carpet grass	4.04	0.11	15.98	0.42	2.87	0.08
Paspalum dilatatum Poir.	Dallis	2.89	0.07	15.98	0.39	0.68	0.02
Pennisetum clandestinum Pers.	Kikuyu	3.81	0.24	16.35	1.03	0.66	0.04
Tricholaena rosea Nees.	Natal red top	0.84	0.10	6.88	0.83	2.57	0.31
Pennisetum setosum Rich. (before flowering)		3.04	0.34	7.34	0.82	1.79	0.20
Pennisetum setosum Rich. (flowering stage)		1.61	0.11	5.01	0.35	1.61	0.11
Pennisetum setosum Rich.		0.91	0.09	8.47	0.87	5.35	0.55
Agrostis sp.	Red top	3.20	0.10	3.52	0.11	0.24	0.008
Chloris Gayana Kunth. (flowering)	Rhodes grass	11.39	0.30	19.57	0.52	0.11	0.003
Chloris Gayana Kunth.	do	5.20	0.23	15.26	0.67	0.06	0.002
Andropogon contortus Linn.	Silat-silatan	3.59	0.16	7.13	0.72	0.17	0.02
Themeda triandra Forsk. (flowering stage)	Silibon grass	10.08	0.14				
Melinis minutiflora Beauv.	Yaragua grass	6.22	0.16	29.81	0.74	0.99	0.03
SILAGE CROPS							
Elephantopus scaber Linn.	Dila-dila	13.00	2.08	4.77	0.76	1.88	0.30
Ipomoea triloba Linn.	Halobagbug	8.27	0.86	15.85	1.65	1.63	0.17
Panicum frumentaceum Salisb. (fruiting)	Japanese millet	11.45	1.12	24.25	2.36	0.82	0.08
Holcus sp. (flowering)	Milo maiz	11.32	1.31	21.61	2.51	0.51	0.06
Holcus sp. (fruiting)	do	8.31	0.18	3.95	0.09	0.02	0.007
Pennisetum purpureum Schum. (before flowering)	Napier grass	4.86	0.36	15.95	1.18	0.16	0.01
Holcus sudanensis Bailey (before flowering)	Sudan grass	5.49	0.62	18.04	2.02	0.10	0.01

Holcus sudanensis Bailey (flowering)	do	3.92	0.41	12.76	1.34	0.16	0.02
Euchlaena mexicana Schrad.	Teosinte			17.35	1.17	0.57	0.004
Saccharum sp. (before flowering)	Uba cane	5.70	0.28	9.26	0.45	0.15	0.007
LEGUMES							
Glycine hispida Maxim.	Soy-bean hay	19.00	1.22	11.48	0.74	0.31	0.02
Phaseolus calcaratus Roxb.	Tapilan-bean hay	18.48	1.49	8.19	0.66	0.59	0.05
Stizolobium deeringianum Bort.	Velvet-bean hay			8.81	0.62	0.27	0.02

Analyses were also made for the calcium, phosphorus, and iron contents of the samples; the data are recorded in Table 2. For the systematic presentation of our results the plants were classified into pasture grasses, silage crops, and legumes.

PASTURE GRASSES

The fat constituent (ether extract) of the pasture grasses varied considerably. Thus adlay (*Coix lachryma jobi* Linn.) contained 6.10 per cent fat, whereas agiñgai (*Cenchrus viridis* Spreng.) had only 1.27 per cent (Table 1).

The fiber content ranged from 16.89 per cent in red top (*Agrostis* sp.) to 40.06 per cent in sibat-sibatan (*Andropogon contortus* Linn.). A number of the samples contained from 30.93 to 40.06 per cent crude fiber.

Carpet grass (*Paspalum compressum* Nees.) had the lowest protein content, 3.87 per cent, while red top had the highest, 10.94 per cent. The average for most of the samples ranged from 5.63 to 8.94 per cent protein.

The lowest amount of ash, 1.34 per cent, was found in silibon grass (*Themeda triandra* Forsk.) and the highest, 12.02 per cent, in natal red top (*Tricholaena rosea* Nees). Eight samples contained from 1.34 to 4.40 per cent ash.

The percentage of nitrogen-free extract ran from 42.63 in *Andropogon contortus* to 65.73 in red top, with most of the samples giving 46.12 to 54.71 per cent.

The phosphorus, calcium, and iron contents (Table 2) of the pasture grasses were extremely variable. Of the fifteen samples analyzed, eight had from 0.10 to 0.19 per cent lime (CaO), six from 0.40 to 0.79 per cent phosphorus (P_2O_5), and seven from 0.005 to 0.04 per cent iron (Fe_2O_3) (Table 4). As a whole the pasture grasses contained more phosphorus than calcium.

SILAGE CROPS

The fat contained in the silage crops varied from 1.54 per cent in napier grass to 4.75 per cent in dila-dila (*Elephantopus scaber* Linn.).

The fiber content was not as variable as that found in pasture grasses, many samples containing from 29.72 to 33.13 per cent.

The percentage of crude protein in the silage crops ranged from 5.38 in Japanese cane (*Saccharum* spp.) to 12.50 in halobagbug (*Ipomoea triloba*).

There was quite a difference in the ash content of the silage crops. Milo maiz (fruiting stage) contained 2.15 per cent ash, while dila-dila (*Elephantopus scaber*) had 15.89.

Numerous samples gave a nitrogen-free extract of 45.53 to 54.72 per cent.

There was a considerable difference in the percentage composition of some samples collected at different physiological periods. Thus milo maiz in the flowering period had 1.90 per cent fat and 11.25 per cent protein. The same plant in the fruiting period contained 2.69 per cent fat and 7.31 per cent protein.

LEGUMES

The legumes as usual contained the highest percentage of protein. Thus velvet-bean hay and soy-bean hay had 18.94 and 14.38 per cent of protein respectively.

DISTRIBUTION OF PLANTS ACCORDING TO COMPOSITION

Table 3 shows the general distribution of forage plants in accordance with the percentage of chemical constituents determined by the customary food analysis.

The distribution of forage plants according to phosphorus, calcium, and iron contents is given in Table 4.

SUMMARY

The proximate chemical composition of some forage plants recently introduced into the Philippines was determined.

Most of the pasture grasses gave 1.26 to 1.92 per cent fat, 30.93 to 40.06 per cent crude fiber, 5.63 to 8.94 per cent protein, and 46.12 to 54.71 per cent carbohydrates.

The majority of the silage crops contained from 2.29 to 2.90 per cent fat, 29.72 to 33.13 per cent crude fiber, 5.38 to 10.68 per cent protein, 45.53 to 54.72 per cent carbohydrates.

Legumes were relatively rich in protein.

There is a wider range of calcium and iron content in pasture grasses than in silage crops and legumes.

The silage crops are relatively higher in phosphorus than the pasture grasses.

ACKNOWLEDGMENT

Thanks are due to Dr. Segundo Alano, of the Philippine Bureau of Animal Industry, for his kindness in furnishing us a number of samples reported in this paper.

TABLE 3.—*Distribution of forage plants according to the percentage of their chemical constituents.*[a]

PASTURE GRASSES

Fat.		Crude fiber.		Protein.		Ash.		N-free extract.	
Samples.	Per cent.	Samples.	Per cent.	Samples.	Per cent.	Samples.	Per cent.	Samples.	Per cent.
9	1.26–1.92	1	16.89–23.00	2	3.87– 4.44	8	1.34– 4.40	2	42.63–45.93
4	2.08–2.46	3	23.52–28.90	10	5.63– 8.94	3	6.27– 9.33	10	46.12–54.71
2	3.32–6.10	11	30.93–40.06	3	9.19–10.94	4	10.14–12.02	3	59.32–65.78

SILAGE CROPS AND LEGUMES

Fat.		Crude fiber.		Protein.		Ash.		N-free extract.	
Samples.	Per cent.	Samples.	Per cent.	Samples.	Per cent.	Samples.	Per cent.	Samples.	Per cent.
4	1.54–1.95	3	18.53–24.64	8	5.38–10.68	2	2.15– 4.87	2	34.36–35.75
6	2.29–2.90	8	29.72–33.13	3	11.25–12.50	6	6.40– 9.75	2	42.61–43.26
8	3.06–4.75	2	40.74–46.87	2	14.38–18.94	5	10.41–15.89	9	45.53–54.72

[a] Percentages based on moisture-free samples.

TABLE 4.—*Distribution of forage plants according to phosphorus, calcium, and iron contents.*[a]

PASTURE GRASSES

Lime (CaO).		Phosphorus (P_2O_5).		Iron (Fe_2O_3).	
Samples.	Per cent.	Samples.	Per cent.	Samples.	Per cent.
3	0.07-0.09	3	0.11-0.39	2	0.002-0.004
8	0.10-0.19	6	0.40-0.79	7	0.005-0.04
2	0.20-0.29	3	0.80-0.99	1	0.05 -0.10
2	0.30-0.34	2	1.00-1.22	4	0.11 -0.55

SILAGE CROPS AND LEGUMES[a]

Lime (CaO).		Phosphorus (P_2O_5).		Iron (Fe_2O_3).	
Samples.	Per cent.	Samples.	Per cent.	Samples.	Per cent.
3	0.18-0.36	2	0.09-0.45	3	0.004-0.007
2	0.41-0.62	7	0.62-1.34	5	0.01 -0.02
5	0.86-1.49	3	1.65-2.36	3	0.05 -0.08
1	2.00-2.08	1	2.50-2.51	2	0.17 -0.30

[a] Percentages based on moisture-free samples.

THE SIGNIFICANCE OF COMPARATIVE ANATOMY IN ESTABLISHING THE RELATIONSHIP OF THE HYPERICACEÆ TO THE GUTTIFERÆ AND THEIR ALLIES.[1]

By P. A. VESTAL

Of the Biological Laboratories, Cambridge, Massachusetts

NINE PLATES AND THREE TEXT FIGURES

INTRODUCTION

The problem forming the subject of this paper grew out of an attempt to harmonize taxonomy and anatomy in the allocation of the Hypericaceæ. It early became evident that no attack on the problem could be complete without some knowledge of the relationship of the Guttiferæ to those families which have at one time or another been allied to it, and of the position of this group in a phylogenetic system of the angiosperms.

In order to understand any system of classification, one must know something about the fundamentals upon which the system is based. In the angiosperms the structure of the flower is generally considered to be fundamental. Increasing knowledge of floral morphology has resulted in various attempts to reconstruct a natural system; these attempts have been aided by the introduction of other external morphological characters as they were better understood.

The introduction of the anatomical method has gone hand in hand with the development of the microscope and of the technic of preparing and cutting anatomical tissues. Certain anatomical characters have long been used in the allocation of specific groups of plants, but only because they have an external expression that can be utilized without further investigation; for example, glands and leaf venation. The development of the anatomical method has given precision to these characters and has furnished new ones. Their study indicates variations. We assume phyletic trends in the external morphology, why not in the internal? It is recognized that floral evolution has been activated in a considerable measure by the intimate relationship of insects to pollina-

[1] Contribution from the Laboratory of Plant Morphology, Harvard University.

tion. It is recognized also that anatomical evolution, more particularly that of the stelar tissues, must have a morphophysiological background rather than that to be ascribed to floral evolution. Can evidence accruing from comparative anatomical study be of value in the clarification of the problem of constructing a natural system on general morphological grounds?

The use of vascular anatomy as an aid in classification is not new, but it requires an enormous amount of work. Consequently it has been restricted to those anatomists who may also have an interest in phylogeny. Great strides have been made in this direction since the time of Hofmeister,(56) principally through the work of Solereder.(104) The primary task is to determine the course of modification in related forms and the relationships existing between them. Both external and internal morphology are the product of at least two factors, heredity and environment. One must determine first those characters which have been acquired independently of the external conditions and therefore may be of phyletic value, and secondly, those that may be due to biological or physiological factors. Observers agree that similarity of structure need not indicate community of descent. Thus the variable characters of phyletic value remain the sole basis of this kind of work.

In anatomy as in taxonomy the way becomes clearer as more and more groups are known. That the plant has developed as a whole is granted. Therefore the trends in the internal structure should be considered, if a natural system is to be the result. There can be no serious consideration of a natural classification on the sole basis of vascular anatomy. It is essentially an auxiliary to taxonomy, but one that should not be neglected. The anatomical history of a group frequently discloses a new point of view regarding affinities which serves to improve our knowledge of the natural system. To construct any scheme based on all the characters known is of course the desired result.

To find the phyletic characters in this series I have, therefore, undertaken an investigation of all available material from the following families: [2]

[2] The arrangement of families is that of the writer, but the families are defined as they are in Engler and Prantl.

1. Dilleniaceæ.
2. Actinidiaceæ (including Saurauiaceæ).
3. Theaceæ.
4. Marcgraviaceæ.
5. Caryocaraceæ.
6. Guttiferæ (including Hypericaceæ).
7. Quiinaceæ.
8. Eucryphiaceæ.
9. Ochnaceæ.
10. Dipterocarpaceæ.
11. Flacourtiaceæ.
12. Cochlospermaceæ.
13. Bixaceæ.
14. Cistaceæ.
15. Canellaceæ.

If phylogenetic trends that meet the demands of taxonomy and anatomy can be identified in these groups, the relationship of the Hypericaceæ to the Guttiferæ can be established on a more definite basis.

The various phylogenetic arrangements of the angiosperms show the treatments of the groups under consideration at this time to be almost as numerous as the authors. In text fig. 1 are listed the phylogenetic trends of these groups as seen by the workers whose names head the various columns.

The above botanists have been selected because they have furnished the systems of classification that are best known at the present time. Certain other botanists have made notable contributions to the systems of plant classification. H. Hallier, in his taxonomic treatment of the angiosperms, (45, 46) treats the groups under consideration as follows: In the Guttales, which he derives through the Dilleniaceæ, he includes several phylogenetic trends that fall into four lines, all coming from the Ochnaceæ, which are considered the basic family of the order and the starting point of several other orders: 1, the Bicornes, including the present Actinidiaceæ and Saurauiaceæ; 2, the Myrtinæ, including the Caryocaraceæ; 3, the Passionales, including the Flacourtiaceæ as the basic family; 4, the main body of the Guttales, including the present Marcgraviaceæ, Theaceæ, Quiinaceæ, Eucryphiaceæ, Cistaceæ (questionable), and Guttiferæ. Parallel orders to the Guttales and of different origin, though themselves related, are the Columniferæ, including the present Bixaceæ and Cochlospermaceæ in the Tiliaceæ, also the Dipterocarpaceæ, and the Anonales including the Magnoliaceæ prior to the Canellaceæ. Wernham (125) separates the Parietales into Parietales A (Guttiferales) and Parietales B (Rosales). Hayata (47) retains the series Parietales in the sense

of Engler and Prantl. Rendle(94) follows in the main the system of Engler and Prantl, but breaks the large complex Parietales of Engler and Prantl into the orders Parietales and Guttiferales, stating that "although the order Guttiferales is closely related to the Parietales, it may be distinguished by its generally axial placentation." Johnson(62) retains the order Parietales of Engler and Prantl.

The presentation of these better-known works will suffice to show the perplexity of the situation. Which of these works approaches more nearly a natural classification? Will vascular anatomy be of aid in answering this question?

The writer takes great pleasure in expressing his deep obligation to Prof. R. H. Wetmore for generous assistance, guidance, supervision, and other expressions of personal interest in this problem.

MATERIALS AND METHODS

The material from the above families includes 120 genera and 537 species, plus numerous varieties and hybrids. Wherever possible, more than one slide has been examined. Several slides were examined when material of the species had been collected from various parts of the world. Each slide was examined with a description of its minute anatomy in mind.

Material collected in the field was killed and fixed, either in a solution of chromo-acetic acid or in formalin alcohol. Specimens from dried woods were made into blocks about 1 cm square, stamped with steel dies, and alternately boiled and drenched with cold water until they sank. Both types of materials were then softened in strong hydrofluoric acid, washed, and dehydrated. The softer materials were embedded in celloidin according to the method used by Jeffrey,(60, 61) Wetmore,(126) and others. All were placed in glycerin alcohol until sectioned. For this purpose a Jeffrey-Thomson sliding microtome was employed. The sections were stained with iron-alum hæmatoxylin and safranin.

Most of the Hypericacæ of North and Central America were collected by the author. Numerous wood specimens were re-

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FOOTNOTES TO FIG. 1

[a] The system of Bentham and Hooker was elaborated when botanists were still imbued with the idea of fixity of species. The system was never intended to express a complete phylogenetic scheme of classification, still one cannot help but wonder how seriously they considered the fixity of species. Certainly they recognized general tendencies and likeness between groups. The system is included here because of its bearing upon the development of later systems of classification.

[b] The families listed in parenthesis are considered part of the preceding family.

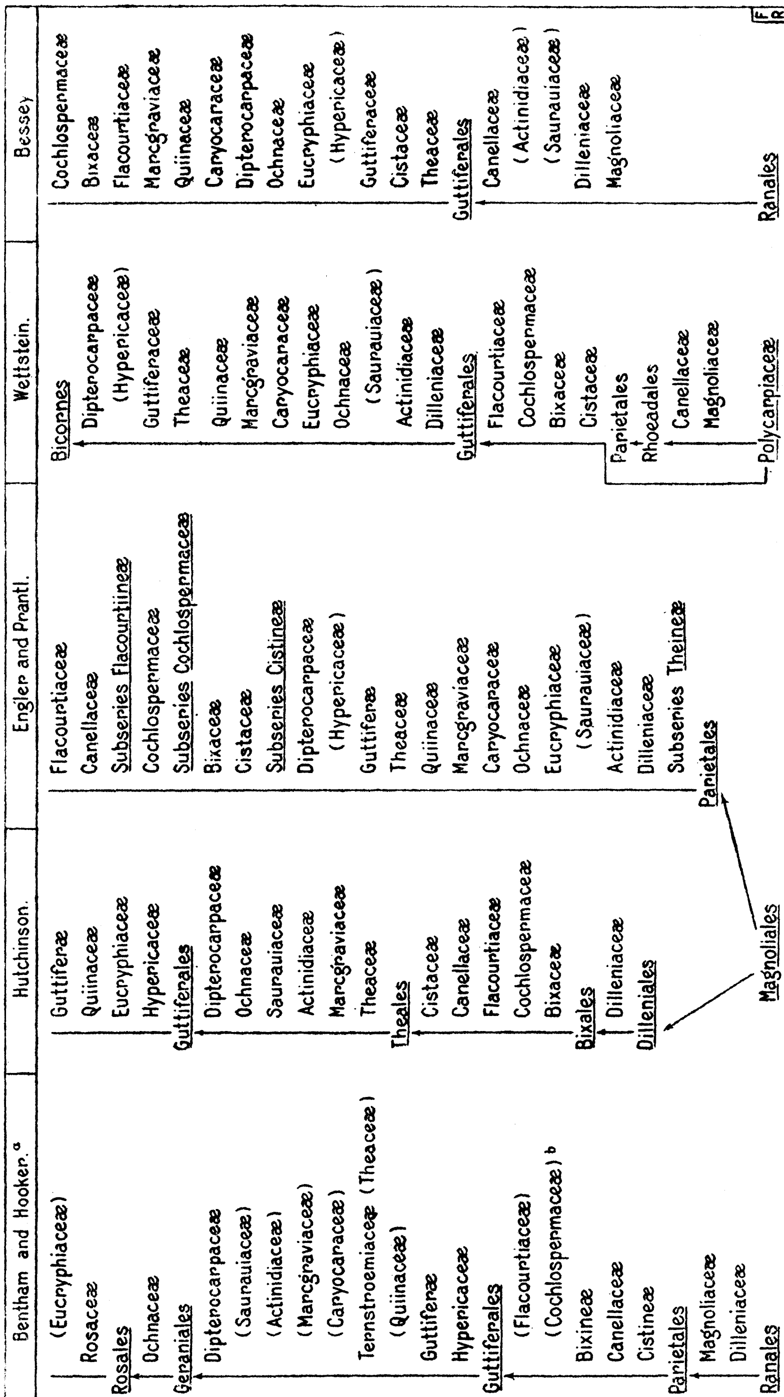


FIG. 1. Phylogenetic trends of angiosperms.

ceived from the world-wide collection of Prof. S. J. Record, School of Forestry, Yale University. Material was also received from the Kew Gardens, England; the Royal Botanical Garden, Edinburgh; the Station Agronomique de la Villa Thuret, Antibes; and the Arnold Arboretum of Harvard University.

The Magnoliales are not included in the present work, due to the recent paper of McLaughlin,(73) but his results were confirmed from the material available. The flacourtiaceous woods examined were those of Prof. W. W. Tupper, who recently published a preliminary work on this group.(116) Numerous slides of this and other groups were made available from the slide collections of Prof. I. W. Bailey and Prof. R. H. Wetmore.

Due acknowledgment is made of the coöperation and courtesy of these different institutions and individuals.

The classification used in the description of the minute anatomy is that of M. M. Chattaway.(20) This classification is the modified system of several earlier writers and was recommended for the consideration of the International Association of Wood Anatomists by a committee appointed by that body. Following this proposed classification, several papers have appeared on the value of measurements in wood anatomy, notably those of Desch,(28) Chalk and Chattaway,(17, 18) and Rendle and Clark,(97) all dealing with specific refinements in ways of measuring and presenting statistical data, for use in the identification of woods. However, the works of Prichard and Bailey(90) on *Carya ovata*, Clark(24) on *Ulmus*, and Bailey and Faull(4) on *Sequoia*, tend to show an even greater range of variability in different parts of a single mature tree than in homologous parts of different trees, with the elements showing a tendency to increase in size for several years, before reaching a more or less stable development. These facts have also been observed by the writer. Since from the available collections it has been impossible to ascertain from what part of a tree or shrub the wood was collected, cell size can be used only in a comparative sense. For this purpose the standards proposed by Chattaway seem adequate.

In the consideration of the general morphology, which accompanies each family, the author has taken freely from the taxonomic works of Wettstein,(127) Rendle,(94) Engler and Prantl,(32) Hutchinson,(59) and Johnson.(62)

The descriptive terms used in the minute anatomy are those suggested by the Committee on Nomenclature, International

Association of Wood Anatomists.(26) These terms are described in more detail and many of them illustrated by Record.(92) The ray types given with the descriptive anatomy are those proposed by Kribs.(70)

MORPHOLOGICAL AND ANATOMICAL DESCRIPTION OF FAMILIES

FAMILY DILLENIACEÆ

This family, as seen by E. Gilg and E. Werdermann in Engler and Prantl,(32) is composed of 11 genera and about 265 species. It is widely distributed in the tropical and subtropical regions, with the main center of distribution in Australia. *Hibbertia,* the largest genus (110 species), is almost exclusively Australian. The present study is based on the anatomical material of 8 genera, represented by 29 species.

Morphology.—Mostly trees or shrubs, very often lianas, seldom subshrubs or perennial herbs; leaves alternate, very seldom opposite, entire or dentate, rarely pinnatifid or trilobed, usually leatherlike with numerous prominent parallel lateral nerves; stipules absent or winglike and adnate to the petiole, mostly deciduous; flowers yellow or white to whitish, seldom red; flowers small to median-sized, rarely large, perfect, rarely polygamous or diœcious; sepals mostly 5, broadly imbricate, persistent and often enlarging; petals mostly 5, imbricate, often unequally wrinkled, deciduous; stamens numerous, rarely definite, hypogynous, free or variously united, usually persistent; anthers with lateral or introrse cells, opening lengthwise or by apical pores; carpels numerous, rarely 1, usually free; style usually free, as many as carpels, with a simple terminal stigma; carpels dehiscent or baccate; seeds mostly with a crested or laciniate aril; endosperm fleshy, copious; embryo straight, mostly minute.

Minute anatomy (*Plate 1, figs. 1 to 4*).—Pores diffuse, mostly solitary, occasionally in pairs, few to very numerous (50 ± in species of *Dillenia, Tetracera, Schumacheria,* and *Wormia*), mostly moderately few, very small to rather large, mostly moderate-sized, oval (Plate 1, fig. 1); vessel members long to extremely long, mostly very long; end wall highly oblique to slightly oblique, scalariform perforation predominant (porous only in the large vessel members of species in the "anomalous" genera *Davilla, Doliocarpus,* and *Tetracera,* but even in these the small vessels have scalariform perforations); bars on the end wall 6 to 130 ±, mostly completely bordered, occasionally bordered only at the end to the middle; intervascular pitting

predominantly opposite, scalariform (Plate 1, fig. 4) and transitional pitting common; vessel-ray pitting with half-bordered pit pairs; tyloses occurring in the end wall in several species of the genus *Dillenia* (Plate 1, fig. 3); rays multi- and uniseriate, heterogeneous, type I (except *Curatella* which is type II A), multiseriate rays very few or few (Plate 1, fig. 2), moderately broad to extremely broad, extremely low to very high (scleroid cells occur in the rays of *Davilla*); parenchyma mostly diffuse, occasionally with several paratracheal cells; fiber-tracheids nonseptate, all with bordered pit pairs (occasionally scalariform pitting in *Dillenia excelsa* Gilg), long, thin-walled occasionally thick (Plate 1, fig. 2), comprising the ground mass of the wood.

The spicular cells, mentioned by Solereder,(104) occurring in the pith of *Davilla, Doliocarpus,* and *Tetracera,* were observed. Stone cells were noted in the cortex of *Davilla, Doliocarpus, Tetracera,* and *Wormia.* No "anomalous" structure was seen in the species of *Doliocarpus* examined, although it has been reported and figured in this genus [Crüger 1850 (Solereder) in *D. Rolandri* Gmel., and later by H. Schenck 1893 (Solereder) in *D. scandens* (Aubl.) Gilg]. The tangential bands of parenchyma mentioned by Möller(80) as occurring in *Curatella americana* L. were not observed in any of the seven collections available.

In all main points, the above observations agree with those of Solereder,(103, 104) Hitzemann,(49) Möll and Janssonius,(79) Record,(91) and Pearson and Brown.(86)

FAMILY ACTINIDIACEÆ

This family as conceived by E. Gilg and E. Werdermann in Engler and Prantl(32) is composed of four subfamilies: I, Actinidiodeæ, with the single genus *Actinidia,* containing 23 species, all of eastern Asia; II, Saurauioideæ, with the single genus *Saurauia,* containing 250 ± species of tropical Asia and tropical America (1 species in northern Australia); III, Clematoclethroideæ, with the single genus *Clematoclethra,* having 10 to 12 species in eastern Tibet and middle China; IV, Sladenioideæ, with the single genus, *Sladenia,* with only 1 species of Burma and southern China. The two latter subfamilies are, as yet, not well known and are included in this family largely due to the work of S. Lechner.(71) In the present study they have been excluded, due mainly to lack of material. The pres-

ent study is based on the anatomy of *Actinidia* (3 species) and *Saurauia* (9 species).

Morphology.—Trees or often climbing shrubs; leaves always alternate, simple, dentate to grooved, glabrous to tomentose, mostly herbaceous, rarely more or less leatherlike, strong parallel nerves diverging from the midrib; stipules 0; flowering mostly in small, axillary dichasia but sometimes also in a paniclelike or many-flowered inflorescence, perfect, polygamous, or diœcious: sepals 5, imbricate, deciduous or persistent, some becoming enlarged and leathery; petals 5, imbricate, mostly membranaceous, free or variously united at the base; stamens ∞ to 10, free or coalescent with base of petal; anthers versatile, opening by short longitudinal split or terminal pore; ovary ∞ to 3 carpels, upright or united laterally, sometimes completely so; styles as many as the carpels, free or more or less united; ovules numerous in 2 series on axial placentation; fruit a berry or more or less regular capsule; seeds numerous or always 1 in each compartment; endosperm abundant, fleshy; embryo straight, one third to three fourths the length of the seeds; cotyledons short.

Minute anatomy (Plate 1, figs. 5 and 6).—Pores diffuse, mostly solitary or in pairs, occasionally in radial chains of 3 to 5, moderately few to numerous (30 ± in *Actinidia melanandra* Franch), very small to medium-sized, mostly small, round or slightly angular; growth rings observed in species of *Actinidia;* vessel members long to extremely long (mostly long in *Actinidia,* very long to extremely long in *Saurauia*); end wall mostly highly oblique, occasionally only slightly oblique, scalariform perforations predominant (Plate 1, fig. 5) (a few porous members in the liana types of *Actinidia*); bars on the end wall 15 to numerous, mostly bordered only at the end, some with slight borders complete; slight spiral thickening observed in species of *Actinidia;* intervascular pitting predominately opposite, scalariform and transitional pitting common (Plate 1, fig. 5); vessel-ray pitting with small borders; tyloses absent; rays uniseriate to multiseriate (4 to 6 cells wide), heterogenous type I, very few to moderately few, very fine to broad (depending on the seriation), very low to rather low, mostly low, very numerous sheath cells occurring in the multiseriate rays in most of the species of *Saurauia* (Plate 1, fig. 6); parenchyma mostly diffuse, pitting frequently unilaterally compound, paratracheal elements scattered in *Actinidia,* forming a 1-layered ring (vasi-

centric) in *Saurauia* (diffuse parenchyma very abundant in *Saurauia*); fiber tracheids nonseptate, all with bordered pit pairs usually in a single line on the sides of the element (Plate 1, figs. 5 and 6), thin-walled, mostly long, comprising the ground mass of the wood in *Actinidia*.

Solereder considers this group as a part of the Theaceæ (Ternstrœmiaceæ). All characters considered in his treatment fall in line with the observed results of Lechner.(71)

Certain characters separate these two subfamilies,[3] but in the main they vary but little from the previously described Dilleniaceæ.

FAMILY THEACEÆ [4]

In Engler and Prantl's(32) treatment of this group by H. Melchoir the family is composed of 23 genera with about 380 species of the tropical and subtropical regions of both hemispheres, with representatives in temperate eastern Asia. Fossil evidence tends to show this family as old and widely distributed. The present work considers the anatomical features as shown by 15 genera and 47 species.

Morphology.—Trees and shrubs; leaves alternate, simple, mostly evergreen; stipules 0; flowers perfect, rarely polygamous or diœcious, spirocyclic or cyclic, mostly solitary, rarely paniculate or racemose, often showy, actinomorphic, bracts often paired below the calyx; sepals 4, 5, 6, or 7, mostly 5, free or more or less united at the base, imbricate, persistent or deciduous; petals 5, seldom 4 or 4–9–∞, free or slightly connate, imbricate, seldom revolute; stamens numerous, seldom definite, arranged in many to one series, free or connate, sometimes adnate to the base of the petals; anthers 2-celled, opening lengthwise, very rarely by terminal pores; ovary superior, sessile, 2 to 10-locular, mostly 3 to 5; styles free or connate, as many as the ovary loculi; ovules 2 to ∞ in each cell, rarely 1, axile; fruit dehiscent or not, loculicidal or septicidal, often leaving a central column of seeds with usually scanty endosperm and straight or curved embryo variously folded or spirally twisted; cotyledons mostly flat, broader or of the same width as the hypocotyl.

[3] Hutchinson(59) treats these subfamilies as separate families, Saurauiaceæ and Actinidiaceæ.

[4] Theaceæ. The author follows the consideration of Engler and Prantl(32) in using this name. They in turn follow the discussion of this point by Sprague(107) and Fawcett and Rendle(34) in which the work of Sprague is accepted.

Minute anatomy (Plate 2, figs. 7 to 12; Plate 3, fig. 13).— Pores diffuse, solitary, in pairs, or occasionally in clusters, moderately few to very numerous, mostly numerous, extremely small to medium-sized, mostly small, oval to angular, growth rings observed in *Camellia, Eurya, Schima,* and *Stewartia,* and indistinct rings in *Anneslea* (Plate 2, fig. 7); vessel members short to extremely long, mostly long or very long; end walls highly oblique with scalariform perforations, 15 to 100 crossbars (Plate 2, figs. 9 and 10), bordered at the end or without a border (the tribes Bonnetieæ, Asteropeieæ, and Tetrameristeæ have slightly oblique end walls with porous perforations and alternate side-wall pitting) (Plate 2, figs. 8 and 12; Plate 3, fig. 13); spiral thickening on the vessel wall of some species; intervascular pitting dominantly transitional scalariform to opposite (Plate 2, fig. 10), except in the tribes noted above; vessel-ray pitting of half-bordered pit pairs, except in the tribe Bonnetieæ where the vessel-ray pitting is simple (Plate 2, fig. 8; Plate 3, fig. 13); tyloses present in the tribes Bonnetieæ and Tetrameristeæ (Plate 2, fig. 12); rays typically heterogeneous, dominantly type I with tendencies to types II and III in the tribe Ternstrœmieæ, dominantly type II A with occasional type II B and type III in certain genera in the tribe Camellieæ, typically type II in the tribe Bonnetieæ, type I in the tribe Tetrameristeæ, and homogeneous type III in the tribe Asteropeieæ, uniseriate, biseriate, triseriate, and multiseriate (4 to 6 cells wide), extremely fine to broad, mostly very fine to fine; multiseriate rays moderately numerous; uni- to triseriate, numerous to very numerous (5 to 15$\pm$); uniseriate rays with multiseriate rays few to numerous; extremely low to rather low, mostly extremely low; parenchyma paratracheal and diffuse, in some species of *Camellia* a tendency to metatracheal bands, 1 cell wide, pitting generally unilaterally compound or clusters (Plate 2, fig. 10), some simple; fiber tracheids nonseptate, all with bordered pit pairs usually in a single line (Plate 2, figs. 8 to 10; Plate 3, fig. 13), occasionally in several series, thin to thick, mostly thick, thick to very thick in the tribes Bonnetieæ, Asteropeieæ, and Tetrameristeæ (Plate 2, figs. 8, 11, and 12; Plate 3, fig. 13), short to very long, mostly long, parenchyma and ray cells containing druse crystals in the genera *Camellia, Gordonia,* and *Schima* of the tribe Camellieæ.

After eliminating the genera now considered in other families, the above work corresponds to that reported by K. Müller,(81)

Solereder,(103, 104) Hitzemann,(49) Möll and Janssonius,(79) Kanehira,(65–67) and Pearson and Brown.(86)

In their minute anatomy certain tribes (Bonnetieæ, Asteropeieæ, and Tetrameristeæ) are not in harmony with the basic pattern exhibited by the rest of the group. On other grounds these tribes have been variously placed in other families, a consideration of which will be taken up in the discussion. The family in the main is rather homogenous as regards anatomical characters, exhibiting a primitive structure in the vessels and fibers, but advanced over the Dilleniaceæ.

FAMILY MARCGRAVIACEÆ

This small tropical American and West Indian family contains about 100 species in 5 genera, according to E. Gilg and E. Werdermann, in Engler and Prantl,(32) which are mostly climbing or epiphytic shrubs with pendulous terminal inflorescences.

The development of an upper bract above the two normal small bracteoles to form a colored nectarsecreting, generally hood- or pitcherlike structure, is of special interest in the family. This is most highly developed in *Marcgravia,* where the central flowers of the inflorescence are abortive and the highly colored bract which has become adnate to the flower stalk is converted into a stalked nectar-containing pitcher with an indication at the base of the small sterile flower (Rendle). The family was included by Bentham and Hooker as a tribe of the Theaceæ (Ternstrœmiaceæ), but because of its peculiar characters is now generally regarded as a separate family. The present study is based on the anatomy of only 4 species representing 3 genera.

Morphology.—Climbing and mostly epiphytic shrubs, rarely arborescent; leaves simple, alternate, sometimes dimorphic; stipules 0; flowers perfect, in terminal racemes or racemose umbels, the bracts of the sterile flowers variously modified into pitcherlike, saccate, or spurred bodies adnate to or free from the pedicel; sepals 4 or 5, free, imbricate; petals 4 or 5, united at the base or joined in a calyptrate deciduous mass; stamens ∞ to 3, free or slightly connate; anthers 2-celled, opening lengthwise; ovary superior, 3- or more-celled; stigmata sessile, radiate; ovules numerous in several rows on thick placentæ; fruit capsulelike, thick and fleshy, globose, indehiscent or slightly dehiscent into the cells at the base; seeds numerous, small, without endosperm; embryo slightly curved, with large hypocotyl and two small cotyledons.

Minute anatomy (*Plate 3, figs. 14 and 15*).—Pores diffuse, solitary to chains and clusters, moderately few to numerous (30 ±), small to large (300 ± in one specimen, *M. rectiflora* Tr. and Pl. 4907 R) oval; no growth rings observed; vessel members short to long [long to extremely long in *Norantea subsessilis* (Bth.) Denn. Smith]; end wall oblique-porous in *Marcgravia* (Plate 3, fig. 14), few-barred-scalariform to multiple in *Souroubea* (Plate 3, fig. 15), highly oblique-scalariform, with numerous bars bordered at the end, in *Norantea;* intervascular pitting opposite in *Norantea,* alternate to coalescent (hexagonal pit pairs) in *Souroubea,* and alternate to coalescent in *Marcgravia;* vessel-ray pitting composed of half-bordered pit pairs; rays heterogeneous type I (mostly upright cells in *Marcgravia* and *Souroubea*), uniseriate and multiseriate (3 to 6), very fine to broad, very low to moderately high, few to moderately numerous; druse crystals occasional in the ray cells of *Marcgravia,* general in *Norantea,* the cells often septate, globules (possibly oil globules) existing in the ray cells and to some extent in the fiber tracheids of *Marcgravia;* parenchyma paratracheal and diffuse, very limited; fiber tracheids thin-walled with bordered pit pairs, comprising the ground mass of the wood, nonseptate and spirally thickened in *Norantea,* septate in *Marcgravia* and *Souroubea.*

Anatomically this is a very heterogenous group, but the genus *Norantea* possesses characters that would seem to link this family very closely to the Theaceæ. Solereder,(104) following the classification of Bentham and Hooker, considers these genera as belonging to the Theaceæ. The author's findings in the anatomy of this group agree with those noted by Solereder.

FAMILY CARYOCARACEÆ

According to R. Pilger, in Engler and Prantl,(32) this family is made up of 2 genera, *Caryocar* with 15 species and *Anthodiscus* with 3 species. Both genera are found in tropical America. The present study is based on 5 species of *Caryocar* and 1 species of *Anthodiscus.*

Morphology.—Trees or shrubs; leaves opposite or alternate, digitately 3- to 5-foliolate; stipules absent; flowers perfect, in terminal ebracteate racemes; calyx 5- or 6-lobed, imbricate or truncate; petals 5 or 6, free or cohering above, imbricate; stamens numerous, subperigynous, in a ring at the base or in 5 bundles; filaments variously bent in bud, sometimes the inner ones without anthers; anthers small, 2-celled, opening length-

wise; ovary 4- or 8- to 20-celled; styles the same number, filiform; ovule solitary in each cell, ascending; fruit rather drupaceous with a woody endocarp breaking up into 1-seeded parts; seeds kidney-shaped with endosperm lacking or very thin; embryo with a large spirally twisted hypocotyl; cotyledons small, hooked-inflexed.

Minute anatomy (*Plate 3, fig. 16*).—Pores diffuse, solitary to chains and clusters (2 to 4), moderately few to numerous, medium-sized to rather large, mostly medium-sized, oval; vessel members long to very long (750 μ $\pm$), mostly long; thin-walled tyloses observed in *C. villosum* (Aubl.) Pers.; end wall slightly oblique-porous, occasionally scalariform in *Anthodiscus;* intervascular pitting alternate, hexagonal in most cases; vessel-ray pitting simple or with slightly half-bordered pit pairs; parenchyma often with unilaterally compound pitting; rays heterogeneous type II A, uniseriate, biseriate, and occasionally triseriate (Plate 3, fig. 16), all the bi- and triseriate rays, with uniseriate extensions, extremely fine to very fine, extremely low to low, very numerous; parenchyma diffuse and slightly paratracheal; septate parenchyma and ray cells containing druse crystals (Plate 3, fig. 16)—frequent in all species of *Caryocar,* absent in *Anthodiscus;* fiber tracheids nonseptate, thick to very thick walls, with simple or very small bordered pit pairs.

The observations agree with those of Solereder,(103, 104) and Record,(91) although both of these authors place this group in the Theaceæ.

FAMILY GUTTIFERÆ

The Guttiferæ as listed by A. Engler and R. Keller, in Engler and Prantl,(32) consist of 46 genera and about 900 species. They are chiefly trees and shrubs, sometimes lianas, inhabiting the high-rainfall tropical areas of the world. The genus *Hypericum* alone is strongly developed outside of the Tropics, distributed in the temperate and mountainous regions of the earth, with great centers of distribution in the Mediterranean, eastern Asia, and eastern America. This genus contains about 200 species and includes all stages from perennial herbs with a persistent rhizome to undershrubs and shrubs. Many of the species have very wide ranges.

This family shows a remarkable diversity in the flower, especially in the number and arrangement of parts. Bracteoles are often developed close beneath the calyx, so that it is impossible to make a sharp distinction as to where the calyx begins; in

many cases this is also true between sepals and petals. A cruciform arrangement, where 2 pairs of sepals are followed by 2 pairs of petals and 2 pairs of stamens with the pistil forming a whorl of 4 carpels—pass through various stages to where a cruciform arrangement characterizes bracteoles and calyx, while petals and stamens are arranged spirally; or sepals, petals, and stamens are spirally arranged. In some cases the flowers are polygamous, as in *Mammea*. The andrœcium shows a great diversity; the stamens may be few, or with various degrees of union in filaments, rarely a cup, more frequently a lobed synandrium, or arranged as in *Hypericum*, in 3, 4, or 5 bundles. The stamens are generally opposite the petals. Staminodes occur variously united or are converted into secretory organs. The carpels are equal in number with the petals, or twice to three times as many, or united into a single whorl. The styles are free or partly united, sometimes very short; the stigmas generally broad.

Morphology.—Trees, shrubs, seldom lianas or herbs, with simple, entire-margined, opposite (rarely alternate or whorled) leaves, all with resinous juice or gland-dotted leaves with no stipules; inflorescence variously cymose; flowers actinomorphic, unisexual, polygamous or diœcious, perfect, sepals 2 to 6, rarely more, imbricate; petals the same number, hypogynous, contorted or imbricate, very rarely subvalvate; stamens mostly numerous, hypogynous, free or various connate in the lower part or into bundles, opposite the petals; anthers 2-celled, opening lengthwise; rudimentary ovary sometimes in the male flower when diœcious; staminodes often present; ovary sessile, superior, mostly 5 or 3, occasionally more (up to 15) or less (2 or 1); ovules 1 to many, on the inner angle or erect from the base of the cells, rarely parietal; stigmas various, sometimes radiating; styles free or partly united, often short; fruit of varied nature, often capsulelike, frequently a stone fruit or berrylike, sometimes large and globose; seeds often arillate, without endosperm; embryo with several different types of development of the hypocotyl in proportion to the cotyledons, frequently with weakly developed cotyledons, sometimes without such.

Anatomy (Plate 3, figs. 17 and 18; Plate 4, figs. 19 to 24; Plate 5, figs. 25 to 30; Plate 6, figs. 31 to 36).—Pores diffuse, solitary, pairs to chains or chains to clusters, occasionally solitary, few to very numerous, mostly moderately few to numerous; exceedingly small to rather large, mostly small to moderate-

sized (Plate 3, fig. 17; Plate 4, figs. 19 to 24), round or oval, mostly oval, growth rings observed in several species; vessel members very short to long, mostly short or long; end wall slightly oblique to transverse, porous [occasionally scalariform or clustered in tribes Clusieæ, Endodesmieæ, and Hypericeæ (Plate 6, figs. 35 and 36)]; intervascular pitting dominantly alternate [scalariform and coalescent in the tribe Clusieæ (Plate 3, fig. 18), frequently coalescent in the tribe Hypericeæ], pits generally large; tyloses quite frequent; vessel-ray pitting simple, or of slightly half-bordered pit pairs; rays uni- to multiseriate, typically uniseriate or uniseriate and multiseriate, heterogeneous, dominantly type I, but occasionally type II A in the tribe Clusieæ, type II A and B with certain genera showing type III in the subfamily Calophylloideæ, the other members of the family are typically type II B with type III dominant or occasional in certain genera (homogeneous type I in the genera *Allanblackia, Pentadesma,* and *Moronobea*), frequently all upright cells or upright cell conspicuous on the margins, uniseriates very fine, extremely low, very numerous; multiseriates fine to broad, extremely low or very low, occasionally rather low, moderately numerous to few (Plates 5 and 6, figs. 25 to 32); parenchyma paratracheal, or aliform to confluent, metatracheal, occasionally diffuse or absent (Hypericeæ) (Plate 4, figs. 19 to 24), parenchyma occasionally septate; fiber tracheids nonseptate (Plate 5, figs. 25 to 30; Plate 6, fig. 31), or septate (in most Hypericeæ and Clusieæ) (Plate 3, fig. 18; Plate 6, figs. 32 and 33), very short, wall very thin to very thick, mostly either thin or thick, pitting bordered or occasionally simple, generally numerous; tracheids surrounding the vessels in Hypericeæ and certain Moronobideæ which form a transition to the vessels; canals in the rays of certain Clusioideæ and Moronobideæ (Plate 5, fig. 27), secretory canals in the cortex frequent. Spiral thickenings were particularly noted in the South American species of *Hypericum* (section *Brathys*) (Plate 6, fig. 34). Nuclei were observed in fiber tracheids of *Hypericum* (Plate 6, figs. 32, 33, 35, and 36), occasionally found in division (Plate 6, fig. 33).

The family is of considerable economic importance. The wood of many species is hard and durable, and many yield valuable resins or gum resins, especially in *Calophyllum, Clusia,* and *Garcinia;* for example, gamboge from *Garcinia Morella.* Others yield edible fruits, such as the mangosteen, and mammee apple (*Mammea americana*). A fatty oil is obtained from the

seeds of *Calophyllum inophyllum, Garcinia indica,* and others; the thick sap of *Pentadesma butyraceum,* the West African "tallow-tree" is used as butter.

The present study is based on the anatomy of 29 genera and 238 species, representing all the tribes as conceived by A. Engler and R. Keller in Engler and Prantl.

As the name Guttiferæ suggests, the presence of intercellular, secretory receptacles (canals, or canals and cavities) is characteristic of the order. Secretory canals are present in the pith and in the primary cortex of the axis in almost all the members of the order; at the same time, they sometimes also occur in the primary and secondary bast, or in the secondary bast only. In the leaf the secretory canals either follow the vascular bundles in the veins or run independently of the vascular bundles in the mesophyll; in the latter case they are sometimes (*Calophyllum*) accompanied by peculiar bundles of tracheids and by sclerenchyma. In some genera the secretory canals of the leaf tissue are in part replaced by secretory cavities (Calophylloideæ and Hypericoideæ).

The above observations agree, in the main, with those of Müller,(81) Solereder,(103, 104) Turner,(117) Ursprung,(118) Möll and Janssonius,(79) Kanehira,(65–67) Jones,(63) Record,(91) and Pearson and Brown.(86)

FAMILY QUIINACEÆ

The Quiinaceæ as listed by A. Engler, in Engler and Prantl,(32) consists of 2 genera, *Quiina* with 16 species and *Touroulia* with 3 species. Both are found in tropical America, northern Brazil, Guiana, and eastern Peru. Only 3 species of *Quiina* were available for the present study.

Morphology.—Trees, shrubs, or climbers; leaves opposite or whorled, simple or pinnately lobed, lateral nerves numerous, tertiary nerves numerous, feather-veined; stipules paired, interpetiolar, rigid or foliaceous; flowers perfect or polygamous, paniculate or racemose; sepals 4 or 5, imbricate in pairs, small, unequal; petals 4 to 8, imbricate; stamens 15 to 30, free or nearly so; anthers 2-celled, opening lengthwise; ovary 2- or 3-celled or 7- to 11-celled; styles 2 or 3, free, linear, with 2 or 3 or 7 to 11 disclike stigmata; ovules paired, ascending; fruit a 1 to 3-seeded berry; seed tomentose; embryo straight; endosperm 0; cotyledons thickened and with a very small hypocotyl.

Minute anatomy (Plate 7, fig. 37).—Pores diffuse, solitary, paired, or occasionally in a chain (3 or 4), numerous, small;

vessel members short to very long, mostly long, oval; end wall slightly oblique, porous; intervascular pitting alternate to coalescent in contact with the ray parenchyma; vessel-ray pitting of half-bordered pit pairs; tyloses absent; rays heterogeneous type I, uniseriate, biseriate, and occasionally triseriate, very fine, extremely low to very low, very numerous; the bi- and triseriate rays with long uniseriate extensions (Plate 7, fig. 37); parenchyma diffuse; fiber tracheids nonseptate, very thick-walled, with numerous well-bordered pit pairs (Plate 7, fig. 37); septate parenchyma containing druse crystals, very rare, in *Quiina Crugeriana* Gris. (4915 R.)

The Quiinaceæ, here regarded as a separate family, are essentially distinguished from the Guttiferæ by the absence of schizogenous resin canals, by the occurence of lysigenous mucilage canals, and possessing type I rays. In regard to their remaining anatomical features the Quiinaceæ fall within the circle of affinity of the Guttiferæ, as a branch of the Theaceæ.

FAMILY EUCRYPHIACEÆ

This family, as treated by E. Gilg, in Engler and Prantl,(32) is composed of the monotypic genus *Eucryphia* with its 4 species. The geographical range of the genus is Australia, Tasmania, and Chile. Three of the species form the basis of the present treatment.

Morphology.—Evergreen trees, leaves opposite, simple or pinnate; stipules small, coalescent; flowers perfect, axillary, solitary, actinomorphic, large, white; sepals 4, rigid, imbricate, cohering at the apex and somewhat calyptrately deciduous; petals 4, large, imbricate; stamens numerous in many series on a thin disc; filaments filiform; anthers small, orbicular; ovary 5- to 18-celled, sulcate, narrowed into 5 to 18 free, slender styles; ovules several, hanging in two series from the inner angle of the cells; fruit a leathery or woody capsule, 5- to 18-valved, valves boat-shaped, beaked by the persistent styles and separating from the axis; seeds pendulous, oblong, compressed, imbricate, winged; endosperm fleshy; cotyledons leafy; hypocotyl short.

Minute anatomy (Plate 7, figs. 38, 39, and 40).—Pores diffuse, solitary to chains and clusters, very numerous (100 to 200 per square mm) occupying a large portion of the transverse section (Plate 7, fig. 38), very small to small (50 μ ±); growth rings observed in all species; vessel members long to very long (750 μ ±), oval-angular; end wall highly oblique, scalariform (Plate 7, figs. 39 and 40), occasionally reticulate or porous,

usually with 20 $\pm$ bars, bordered only at the ends, slightly spiral thickening noted in two species, none in *E. cordifolia* Cav.; intervascular pitting transitional, scalariform to opposite (Plate 7, figs. 39 and 40); vessel-ray pitting simple to half-bordered pit pairs; tyloses absent; rays uniseriate, biseriate, and occasionally triseriate, heterogenous types II B and III (approaching Homo III in *E. Bittardieri* Spach., the Tasmanian species), very numerous, very fine to fine, extremely low to very low, all ray cells containing a dark-brown-stained substance; parenchyma mainly diffuse, becoming metatracheal or terminal near the growth rings (Plate 7, fig. 38); fiber tracheids nonseptate, thick walls with bordered pit pairs in single rows on the sides of the elements (Plate 7, figs. 39 and 40).

The genus is a very homogeneous one, with a rather primitive array of characters, except in ray type. The above description is in agreement with that of Record.(91)

FAMILY OCHNACEÆ

This family, as seen by E. Gilg in Engler and Prantl,(32) is composed of 20 genera containing about 370 species distributed in the Tropics of the world, especially in Brazil. The family is divided into 2 large tribes, the Exalbuminosæ and the Albuminosæ, on the basis of absence or presence of endosperm in the seed. The present study is based on 8 genera and 26 species, of which 5 genera and 21 species are found in the tribe Exalbuminosæ.

Morphology.—Trees or shrubs with watery juice, rarely herbs; leaves alternate, simple, very rarely pinnate, often with numerous pinnate nerves; stipules present, sometimes laciniate; flowers perfect, actinomorphic or occasionally more or less zygomorphic, mostly racemose or paniculate; sepals mostly 5, rarely 10, free, imbricate or rarely contorted; petals free, 5 to 10, subsessile, contorted or imbricate; stamens few to many, free, staminodes sometimes present, subulate or petaloid, sometimes connate into a tube; filaments persistent; anthers linear, basifixed, opening lengthwise or by a terminal pore; ovary entire to deeply lobed, 1- to 10-celled; ovules 1 to ∞, axial or parietal or attached to the intrusive placentæ; style simple or split at the apex; fruiting carpels often becoming quite separate on the enlarged torus, and drupaceous, or elongate, capsular, and septicidal; seeds 1 to many, with or without endosperm; embryo usually straight.

Minute anatomy (Plate 7, figs. 41 and 42; Plate 8, figs. 43 to 45).—Pores diffuse, mostly solitary or in pairs, occasionally in

radial chains or clusters, few to very numerous, mostly moderately numerous to numerous, very small to moderate-sized, round to oval (Plate 7, figs. 41 and 42); growth rings in a few species; vessel members very short to long, mostly short; end wall oblique-porous; intervascular pitting alternate, pits dominantly very small and numerous; tyloses rare; vessel-ray pitting simple or of slightly half-bordered pit pairs; rays uniseriate to multiseriate (4 to 6 cells wide) heterogenous, typically type I in the subfamily Albuminosæ, dominantly type I in the Exalbuminoseæ but closely approaching type II A, homogeneous type II in *Lophira,* uniseriate, very fine to occasionally fine, numerous to very numerous, extremely low to very low; multiseriate, mostly moderately broad, occasionally broad, few to numerous, low to moderately high (Plate 8, figs. 44 and 45); parenchyma paratracheal, metatracheal, and diffuse, metatracheal most common in the genus *Lophira* (5 or 6 cells wide) (Plate 7, fig. 42; Plate 8, fig. 43); crystals occasional in most genera, either in the ray parenchyma or longitudinal parenchyma, parenchyma containing these crystals frequently septate; fiber tracheids nonseptate or septate, thin to very thick, mostly thick to very thick, mostly long, pit pairs simple or slightly bordered, generally numerous.

A common anatomical character is the presence of leaf-trace bundles in the cortex (Rendle). Douliot (Solereder) also gives cortical bundles as a common character of the Dipterocarpaceæ. The two subfamilies, Exalbuminosæ and Albuminosæ, as the names imply, are separated on the basis of the presence or absence of endosperm. Anatomically they can be separated by the presence of vestured pits in the Exalbuminosæ, lacking in the Albuminosæ (Bailey).(3) In the members of the Albuminosæ the upright ray cells are much more elongate, making the ray more heterogeneous than in the Exalbuminosæ. Also, septate fiber tracheids are present in certain of the Albuminosæ, and completely absent in the Exalbuminosæ.

The genus *Lophira* is included in the Dipterocarpaceæ by Bentham and Hooker, but placed in the Ochnaceæ by Gilg. According to Van Tieghem(113) it differs in lacking resin canals and in the stratification of the bast, which is peculiar to the Dipterocarpaceæ. Rendle states: "In *Lophira,* a monotypic genus of tropical Africa, the two outer sepals become much elongated in the fruit forming a wing which ensures distribution (compare Dipterocarpaceæ)." Anatomically *Lophira* possesses metatracheal parenchyma and vestured pits, also characteristic of the Dipterocarpaceæ. It seems quite possible that the Exalbuminosæ

of the Ochnaceæ connect with the Dipterocarpaceæ through the genus *Lophira*.

FAMILY DIPTEROCARPACEÆ

The Dipterocarpaceæ, as presented by E. Gilg in Engler and Prantl, (32) consist of 19 genera in 2 subfamilies containing over 350 species of trees, rarely shrubs, inhabiting the tropical forest of India, the Malay Peninsula, the East Indian Islands, and tropical Africa. Its members produce many valuable timbers, and many yield important oils, resins, and copal. The present study is based on woods representing 8 genera and 60 species.

Morphology.—Trees, rarely shrubs, with resinous wood; leaves alternate, simple; indumentum of stellate hairs or of peltate scales; stipules small or large, deciduous; flowers perfect, actinomorphic, fragrant, in axillary panicles; bracts usually absent; calyx tube short or long, free or adnate to the ovary; lobes 5, imbricate or valvate, usually enlarged and winglike in fruit; petals 5, much twisted, free or slightly connate, often hairy; stamens 5, 10, 15, or more, in 1 or more cycles, hypogynous or subperigynous; anthers 2-celled, opening lengthwise; ovary 3-celled; style entire or 3-lobed; ovules 2 in each cell, pendulous or lateral, anatropous; fruit indehiscent, mostly 1-seeded; seeds without endosperm; cotyledons often twisted, inclosing the hypocotyl.

Minute anatomy (*Plate 8, figs. 46 and 47*).—Pores diffuse, mostly solitary or in pairs, occasionally in short chains or clusters, mostly few or moderately few, occasionally moderately numerous to numerous, medium-sized to rather large, occasionally small, oval (Plate 8, fig. 46) ; vessel members short, occasionally very short or long; end wall porous; tyloses frequent; intervascular pitting alternate, with a few coalescent pits in some species, vestured pitting frequent; vessel-ray pitting simple, rarely bordered; rays uni- to multiseriate (3 to 6 cells wide), heterogeneous type II B; uniseriate rays very numerous, extremely fine to very fine, extremely low to very low; multiseriate rays moderately numerous, fine to moderately broad; occasionally septate ray cells containing crystals; parenchyma diffuse, aliform to confluent and in other cases definitely metatracheal, occasionally septate parenchyma with crystals, resin canals occurring in bands or groups of parenchyma (Plate 8, fig. 46) ; fiber tracheids nonseptate, mostly with slightly bordered pit pairs, or simple, short to long, thick to very thick or occasionally thin-walled, usually in bands alternating with parenchyma.

Bailey(3) records the presence of vestured pits in this family, and these were observed by the author in several of the genera. Douliot (Solereder) mentions as a common character of the Dipterocarpaceæ the presence of cortical bundles. Guerin (Solereder) states that the resin canals in this order are schizogenous in origin, and arise between four cells of the cambium. The presence of these resin canals in the secondary xylem and elsewhere has been used by several authors (Rendle, Engler and Prantl, and others) as indicating relationship with the Guttiferæ.

The above work is in agreement with that of Müller,(81) Solereder,(103, 104) Hitzemann,(49) Möll and Janssonius,(79) Foxworthy,(36, 73) Reyes,(99) Pearson and Brown,(86) and Bailey.(3)

FAMILY FLACOURTIACEÆ

According to E. Gilg, in Engler and Prantl,(32) this family includes 84 genera and about 800 species of woody plants, often forming large trees with a wide distribution in the Tropics. It includes the Samydaceæ and a part of the Bixaceæ of earlier classifications and is divided into 11 tribes. The present study is based on the secondary anatomy of 32 genera and 90 species, representing 6 tribes.

Morphology.—Trees or shrubs; leaves simple, alternate, generally thick, leathery and evergreen; stipules often soon falling off; flowers perfect, monœcious or diœcious, rarely polygamous, generally small and arranged in lateral or terminal cymes, but in *Oncoba* often very large and generally axillary, regular, structure varied, generally cyclic but sometimes spirocyclic; sepals 2 to 15, sometimes not distinguished from the petals, imbricate or open in bud, sometimes united below to form a short tube, which is united with the ovary, the ovary becoming half inferior (inferior in *Bembicia*); petals sometimes not arranged regularly in relation to the sepals, large, small or absent, with or without an opposite scale inside the base, imbricate; stamens numerous, rarely few, in one or two whorls or apparently irregularly arranged, hypogynous, free; anthers 2-celled, often short, opening lengthwise by slits, ovary 1-celled of 2 to 10 united carpels with 1 or more parietal placentæ or rarely the placentæ meeting in the middle; ovules 2 or more on each placenta; styles or stigmas as many as the placentæ; fruit indehiscent, mostly a berry or drupe, very rarely a capsule, sometimes large; seeds with fleshy endosperm and medium-sized embryo; cotyledons often broad.

Minute anatomy.—Pores diffuse, mostly solitary or in pairs, occasionally in short chains or clusters, moderately few to very

numerous, mostly numerous, very small to moderate-sized, mostly small, oval; vessel members short or long, occasionally very short or very long; end wall typically porous, although scalariform perforation plates occur in several genera of the tribes Oncobeæ and Pangieæ, but even here simple perforations are the rule and may occur side by side with the scalariform type; tyloses occasionally, intervascular pitting typically alternate, but here again in the tribes Oncobeæ and Pangieæ transitional pitting is the rule; vessel-ray pitting generally of slightly half-bordered pit pairs; rays uni- to multiseriate (3 to 5, occasionally to 10 cells in width) heterogeneous, type I in the tribe Oncobeæ, type I with a greater tendency to type II in the tribes Pangieæ and Homalieæ, both types I and II A in the tribes Scolopieæ and Casearieæ, and types II A and B in the tribe Flacourtieæ; uniseriate rays, numerous, fine, very low to low, occasionally extremely low; multiseriate rays few to moderately numerous, very low or rather low, typically with vertically elongate uniseriate extensions, occasional crystals in the ray cells; parenchyma typically absent, when present very scanty and paratracheal; fiber tracheids generally septate, very thin or thin-walled with slightly bordered or simple pit pairs, short to long; in fiber tracheids with a thick wall a definite concentric pattern in the wall is seen in cross section. These elements comprise in most cases the ground mass of the wood.

This family is capable of being grouped into tribes that are obviously related but possess tendencies leading in several directions from the more primitive tribes. This is quite apparent from the study of the vessel members and the ray types. The tribes agree very closely with the phylogenetic relationships proposed by Engler and Prantl.(32) The most constant characters in the secondary xylem are the generally septate fiber tracheids, which in the thick-walled types studied are concentric, and the absence or scanty development of the parenchyma.

The findings in this group, early considered in the Bixineæ, agree in most essential details with those reported by Solereder,(103, 104) Turner,(117) Möll and Janssonius,(79) Kanehira,(65) Record,(91) and Tupper.(116)

FAMILY COCHLOSPERMACEÆ

R. Pilger, in Engler and Prantl,(32) considers this family as composed of 3 genera containing 23 species, *Cochlospermum* with 15 species in the Tropics of the Old and New Worlds;

Amoreuxia with 6 species in Central America, and *Sphærosepalum* with 2 species in Madagascar. The present work is based on the single species *Cochlospermum vitifolium* (Willd.) Spreng. of Mexico and northern South America.

Morphology.—Trees, shrubs, or rhizomatous subshrubs with colored juice; leaves alternate, palmately lobed, stipulate; flowers perfect, paniculate or racemose; sepals 5, imbricate, deciduous, petals 5, imbricate or subcontorted; stamens numerous; filaments free, but many vary in height; anthers 2-celled, linear, opening by terminal, often confluent, porelike slits; ovary 1-celled with parietal placentæ or perfectly 3-celled; ovules numerous; style simple with small denticulate stigma; fruit a 3- to 5-valved capsule; seeds glabrous or hairy, straight or reniform; endosperm copious; embryo conforming to the shape of the seed, large; cotyledons broad.

Minute anatomy (Plate 8, fig. 48).—Pores diffuse, solitary, in pairs, occasionally in chains of 3 or 4, moderately numerous (15±), medium-sized; growth rings not seen; vessel members long, slightly oblique with porous end wall; no spiral thickening; intervascular pitting alternate, pits numerous and crowded (Plate 8, fig. 48); vessel-ray pitting simple to half-bordered; tyloses absent; rays uniseriate to multiseriate (1- to 4-seriate), heterogeneous type II B, upright cells rather square, fine to moderately broad, very low to low, very numerous, some of the larger rays containing ducts; parenchyma paratracheal, 1 or 2 cells wide, usually connecting with the metatracheal bands which are 5 to 8 cells wide and very conspicuous; fiber tracheids very short, very thin-walled, with quite numerous, small, bordered pit pairs. The fiber tracheids and metatracheal parenchyma comprise the ground mass of the wood (Plate 8, fig. 48).

FAMILY BIXACEÆ

This small monotypic family is composed of the genus *Bixa* with 2 species, *B. Orellana* L. and *B. arborea* Huber, according to R. Pilger, in Engler and Prantl.(32) The outstanding species, *B. Orellana* L., is a tree native of tropical America but cultivated throughout the world for the red annatto or orleans dye, which is made from its fleshy seed coat. *Bixa arborea* Huber is a tree of the Amazon region. The present work includes both species.

Morphology.—Shrubs or small trees with colored juice; leaves alternate, simple palminerved, stipulate; flowers perfect,

medium-sized, showy, paniculate; sepals 5, imbricate, deciduous; petals 5, large, imbricate, without a scale at the base; stamens numerous, hypogynous; filaments free, anthers horseshoe-shaped, opening by short slits at the top; ovary superior, 1-celled, with 2 parietal placentæ; ovules numerous; style slender, recurved in bud; stigma 2-lobed; fruit a densely echinate-setose or smooth capsule, 2-valved, valves thick with the placentæ in the middle; seeds obovoid; testa rather fleshy, red; endosperm copious; embryo large; cotyledons broad, incurved at the apex. Characteristic of the Bixaceæ is the anther form and the formation of the seed coat.

Minute anatomy (*Plate 9, figs. 49 and 50*).—Pores diffuse, chains to clusters, oval, numerous to very numerous (80 ±) (Plate 9, fig. 49); vessel members small to medium-sized (100 ±), short; end wall slightly oblique to transverse, porous; intervascular pitting alternate, pits very small and crowded; vessel-ray contact with half-bordered pit pairs; rays uni- and biseriate, occasionally triseriate, heterogeneous type II B; very fine, extremely low to very low, very numerous, appearing storied in tangential section (Plate 9, fig. 50); parenchyma mostly diffuse, composed of wood parenchyma strands of 4 cells, occasionally paratracheal, thin-walled; fiber tracheids nonseptate, very thin, bordered pit-pairs quite small, not numerous. The fiber tracheids form the ground work of the wood.

FAMILY CISTACEÆ

The Cistaceæ as defined by E. Janchen in Engler and Prantl, (32) consist of 8 genera and 170 species of herbs or shrubs, with the Mediterranean region as the large center of distribution but with certain genera along the Atlantic coast of North America to the West Indies. The present study is based on the minute anatomy of 4 genera and 7 species.

Morphology.—Herbs or shrubs, often with stellate indumentum; leaves opposite, rarely alternate, simple; stipules present or adnate to the petiole; flowers perfect, actinomorphic, solitary to cymose, showly; sepals 3 to 5, contorted; petals 5 to 0, contorted, early deciduous; stamens numerous, hypogynous; filaments free; anthers 2-celled, introrse, opening lengthwise; ovary superior, 1-celled with parietal placentæ or incompletely septate towards the base; ovules 2 or more to each placenta; style simple with 3 to 5 free or united stigmas; fruit a capsule opening by valves from the top downward; seeds with endosperm and having a bent, coiled, or folded embryo.

Minute anatomy (*Plate 9, fig. 51*).—Pores diffuse, solitary, very numerous, very small, round to slightly oval; vessel members very short; end wall slightly oblique, porous, occasionally 1 to 3 simple perforations at one end; tyloses rare; intervascular pitting alternate, few or quite numerous, very small; vessel-ray pitting of slightly half-bordered pit pairs; growth rings in a few cases; rays in *Cistus* and *Lechea* (in part) 1- to 3-seriate, heterogeneous types II B and III, usually upright cells, extremely fine to very fine, extremely low, very numerous (Plate 9, fig. 51); rays in *Helianthemum, Hudsonia,* and *Lechea* (in part) uniseriate, heterogeneous type III; 1 to 3 cells tall, vertically elongate, very irregular in shape, and inconspicuous, parenchyma absent; fiber tracheids thin-walled, very short, nonseptate, with slightly bordered pit pairs (Plate 9, fig. 51).

Solereder(104) in quoting Piccioli's investigations, states: "In the wood, medullary rays are not present in *Lechea,* whilst in the remaining genera they are narrow and mostly uniseriate. As a rule the bulk of the wood is composed of prosenchyma with bordered pits; in the species of *Helianthemum* belonging to the section *Eriocarpum* however, the tracheids are replaced by mechanical elements. Wood-parenchyma only occurs in relatively small amounts."

As has been noted above, the writer observed ray cells in all genera and species, although *Helianthemum, Hudsonia,* and *Lechea* (in part) showed only uniseriate rays, 1 to 3 cells tall, vertically elongate, and irregular in shape. Except that these cells are arranged in a radial manner, they might easily have been mistaken for longitudinal parenchyma. However, there can be no doubt that these radial seriations of cells are rays.

Turner(117) considers this group as nearly related to the Hypericaceæ, and that both groups show a relationship to the Flacourtiaceæ and Bixaceæ ("Bixaceen").

FAMILY CANELLACEÆ

E. Gilg's account of this family in Engler and Prantl(32) shows it to include 4 genera and 8 species, each genus limited in distribution. *Canella* (2 species) is found in the West Indies, southern Florida, and Columbia; *Cinnamosa* (2 species) in Madagascar; *Warburgia* (3 species) in East Africa; and *Pleodendron* (1 species) in Porto Rico. The present work is based on several collections of a single species in each of the first 3 genera mentioned.

Morphology.—Trees, seldom shrubs, leaves alternate, simple, glabrous, aromatic, gland-dotted; stipules absent; flowers perfect, actinomorphic, cymose; bracts 3, imbricate, persistent; sepals 4 or 5, free, thick, imbricate; petals thin, imbricate or absent; stamens hypogynous, up to 20; filaments connate into a tube with the anthers adnate to its outer side, opening lengthwise by valves; ovary superior, 1-celled; placentæ 2 to 6, parietal; ovules 2 to ∞ ; style thick; stigmas 2 to 6; ovules subanatropous; fruit a berry; seeds 2 or more, shining; endosperm oily and fleshy; embryo straight.

Minute anatomy (Plate 9, figs. 52 to 54).—Pores diffuse, solitary or in pairs (Plate 9, fig. 52), rarely clusters; moderately numerous to very numerous (*Capsicodendron*), small, occasionally very small (*Capsicodendron*); growth rings not observed, vessel members long to occasionally extremely long, mostly very long; end wall highly oblique, scalariform perforate, crossbars 12 to 60, completely bordered or bordered at the end to middle; intervascular pitting transitional to opposite, pits few; vessel-ray pitting of half-bordered pit pairs; tyloses absent; rays uniseriate, occasionally by- or triseriate, homogeneous types I and III (Plate 9, figs. 53 and 54), very fine, extremely low to very low, very numerous (10 to 15 $\pm$), unilateral compound pitting present; druse crystals in the rays (Plate 9, fig. 54) (except *Capsicodendron*); parenchyma paratracheal (2 to 4 cells wide on one side of the vessel) (Plate 9, fig. 52), occasionally also diffuse; fiber tracheids nonseptate, thin or thick; pit pairs well bordered and large. The fiber tracheids form the ground mass of the wood in all but *Capsicodendron*, in which the parenchyma is conspicuous.

DISCUSSION

I. GENERAL

If we are to use comparative morphology in the interpretation of trends in the angiosperms, as has been done by the authors of the numerous systems, we must first understand the dicta upon which these classifications have been founded. In the present treatment we accept, as a working hypothesis, that the floral morphology of a majority of the dicotyledons may be traced back to a primitive ancestor, possibly "Ranalian." With this hypothesis as a basis, following the works of Bessey,(7–9) Wernham,(125) Hallier,(45) Arber and Parkin,(1) Sprague,(108) and Hutchinson,(59) we assume that: The bisexual preceded the

unisexual flower; spirally imbricate floral parts are more primitive than the whorled or valvate; the polymerous flower precedes and the oligomerous follows; polypetaly is more primitive than gamopetaly; actinomorphy of the flower precedes zygomorphy; hypogyny gives rise to perigyny and epigyny; apocarpy is more primitive than the connate resultant; polycarpy precedes oligocarpy; free styles precede connate styles; the endospermic seed with small embryo is primitive and the nonendospermic derived; many stamens are more primitive than few stamens; separate stamens precede connate stamens; the presence of stipules is more primitive than the absence of stipules; and trees preceded shrubs and herbs. We believe with Sprague(108) that a natural classification should be based on the synthetic method; that is, the adding of group to group according to the agreement between the sum total of their characters, and that the greater the number of common characters the closer the affinity, though tendencies should not be disregarded.

In the interpretation of the minute anatomy for purposes of classification of the angiosperms certain well-recognized principles have been established by several workers—Solereder,(104) Jeffrey,(60) Bailey and Tupper,(5) Frost,(38–40) and Kribs.(70) A summary of these principles follows:

(*a*) *Vessels.*—Frost, following and enlarging the work of Brown(13) and Thompson,(112) argues that the vessel member is phylogenetically related to and derived from the tracheid, and finds by correlation that long members having scalariform perforations with numerous bars, completely bordered on a highly inclined end wall, and with scalariform lateral pitting, are primitive. Similarly the most highly evolved vessel members are short with transverse porous perforations and with alternate side-wall pitting. All other types of vessel members are considered to be transitions in various degrees of specialization. A bordered pit in contact with a simple pit of parenchyma is considered more primitive than a simple pit pair. The distribution of vessels is a variable character. Spiral thickening would seem to have little value in the broader complexes. This is also true of tyloses.

(*b*) *Xylem parenchyma.*—The scanty or abundant occurrence of wood parenchyma is of considerable significance. The presence of septate-parenchyma containing crystals in the wood is generally only of specific value. The diffuse arrangement is considered more primitive than aggregates of parenchyma.

(*c*) *Rays*.—Bailey,(2) Myer,(82) DeSmidt,(30) and Weinstein(124) find the number of rays in similar annular rings of different individuals of the same species, and even within the same tree, is subject to great variation. This is particularly true of the multiseriate rays, which are found to be more numerous in the root and lower part of the stem than in the upper part of the stem; and to be more numerous in branches, especially on the lower side, than in the trunk. The number of uniseriate rays remains more nearly constant. Thus the number or volume of the rays, especially the multiseriate rays, cannot generally be considered of great diagnostic value.

Kribs(70) from observations of a large number of dicotyledonous woods finds certain salient lines of structural specialization in the wood rays. Based on a high correlation between vessel type and ray type, he segregates the rays into six classes or types. The homogeneous rays are considered more highly specialized than the heterogeneous rays. The primitive heterogenous condition is with the "uniseriate rays usually high, numerous and composed of very large, vertically elongated cells which are unlike the cells of the multiseriate part of the multiseriate" and with "multiseriate rays usually with parallel sides and with very large, vertically elongated, uniseriate wings (long wings) which are composed of cells identical with those of the uniseriate rays; the cells of the multiseriate portion of the rays are oval, radially elongated or vertically elongated." By a shortening of the extensions and the uniseriates, and by the elimination of the multiseriates, the other types of heterogeneous rays are derived. From these types the homogenous types are derived. Kribs, in his discussion, states that "the uniseriate rays occur as an offshoot in practically every type of woody dicotyledonous stem, indicating that it is a specialized structure due to the elimination of multiseriate rays." Since the primitive ray type in living dicotyledonous woods contains both uniseriate and multiseriate rays, when the multiseriates are eliminated, a more specialized wood is the result, and not necessarily a more specialized ray, as the cell type in the ray may remain the same. A similar result is obtained when the uniseriates are eliminated, leaving the multiseriates. It was found, in using the classification proposed by Kribs, that the specialization cells composing the uniseriate rays were a much better indicator of the type than the cells of the multiseriate ray; that is, the uniseriate rays are much more constant in

type within a group or a single specimen than are the multiseriate rays.

(*d*) *Tracheids, fiber tracheids, and fibers.*—The phylogenetic series is considered to have been in the order just indicated; namely, tracheids, fiber tracheids, and fibers. The tracheid is an imperforate, thin-walled cell with the pits to congeneric elements bordered. The fiber tracheid is commonly thick-walled, with small lumen, pointed ends, and with small bordered pits having lenticular to slitlike apertures. The fiber is similar to the preceding but with simple pits. Although the distinction between fibers and fiber tracheids is simple in itself, the maintenance of this distinction, which is very important, becomes very difficult, when the borders of the pits are very small. A simple slit-shaped pit occasionally appears to have a slight border when seen in surface view. The transverse section of the pit can alone decide whether the pit is really bordered or not. The presence of septate fiber tracheids is quite characteristic of large groups and thus may be of value. Solereder (104) and Frost (38) find a high correlation between scalariform-pitted lateral walls of vessel members and fiber tracheids.

II. FAMILIES

Hypericaceæ.—The genus *Hypericum*, the largest in the Hypericaceæ, contains, according to R. Keller in Engler and Prantl, about 300 species of shrubs and herbs, widely distributed, but with four main centers of distribution: (*a*) The Mediterranean complex, including all of Europe, the islands of the Middle Atlantic, northern Africa, and Asia Minor; (*b*) the African continent, and equatorial and South Africa; (*c*) eastern and southeastern Asia (Japan included), the Himalayan region, islands of the Indian Ocean, and Australia; (*d*) both American Continents. The species of any of these regions segregate very clearly into well-marked sections.

This genus displays in its floral morphology an extremely wide variation as to the number, distribution, and fusion of stamens, the number and fusion of styles and carpels, and the types of placentation. A part of this range of variation can be seen in text fig. 2.

Other characters, which have proven significant in the taxonomy of this genus, are: (*a*) The type of inflorescence, which is basically cymose; (*b*) the placentation, which, though generally axile, may become parietal; (*c*) a wide range of seed

characters [Keller, in Engler and Prantl,(32) Stefanoff(110, 111)].

The secretory organs, which are characteristically present in this group, are schizogenous in origin, as shown by Weill,(123) Kienast,(69) and others. They may be either secretory sacs or canals. The sacs are found in the leaves of all species in the genus, as well as in all other members of this family. The secretory canals in this genus are located principally in the pericycle

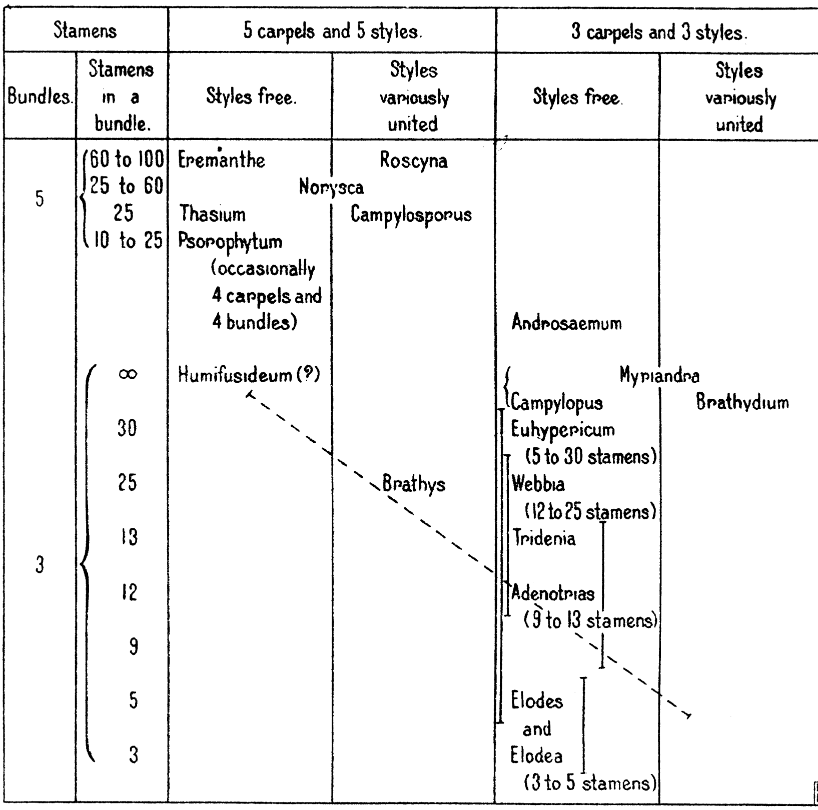


FIG. 2. Variations in the genus *Hypericum*.

and phloëm of the root and stem, but frequently are found in the leaves and flowers. In a few cases the canals are cortical or medullary. On approaching a node they usually divide once to several times. Clos(25) proposed a key to the genus based on the type and distribution of these secretory organs. The content of the sacs and canals in the genus is an oil containing a pigment. Microchemical tests indicate that the pigment is an

anthocyanidin, probably in part a rhamnose glucoside of pelargonidin [Siersch(100)]. The plants possess a toxic principle that has made certain species obnoxious weeds in cattle and sheep country [Marsh and Clawson,(74) and others].

The cytological behavior within the genus is not too well known. The numbers of chromosomes reported by Chataway,(19) Tischler,(115) Hoar,(50) and Hoar and Haertl(51) were: 7–8–9–10–12–16–19–20, with comparatively few of the species examined. Nielsen(83) does not believe that this represents an arithmetical series as proposed by Winge. However, he makes no statement as to an interpretation of these chromosome numbers. Wanscher,(122) in a statistical study of chromosomes from many families of plants, considers that the chromosome numbers in higher plants originate from a number belonging to a 4-system; that is, with other numbers either way in an ascending or descending series. In the genus *Hypericum* he regards the number 8 as the probable basic number, with the other numbers as probable derivatives. Natural hybridization is common in *Hypericum* [Kerner and Oliver(68)].

At the present state of our knowledge, nothing of definite phylogenetic value can be drawn from such studies as have been made on the secretory tissues or the cytogenetics of the genus.

In the one hundred odd species (plus numerous varieties and hybrids) of *Hypericum* that have been examined, no segregation of anatomical groups was possible. Rather the genus displayed in its vascular anatomy a very constant homogeneity. The herbs are of the reduced shrub type, possessing a continuous stele but with a reduction in the size of the central stele and a greater development of pith [Eames,(31) Sinnott and Bailey,(102) Sinnott,(101) Bews(10, chap. 4)]. The shrubs in turn are doubtless reductions of tropical tree ancestors, as they possess a generally more subtropical distribution than the herbaceous members.

In its minute anatomy, the genus *Hypericum* shows vessel members that are very short, generally extremely small and very numerous, with the end wall slightly oblique with simple perforations predominant, but with scalariform or clustered perforations occurring in certain species. The side-wall pitting is alternate, with a tendency to coalescence in contact with ray cells. Tracheids occur around the vessel in some members and show transitional stages to vessels. The rays are typically uniseriate (Plate 6, fig. 32), although bi- and triseriate rays are

occasionally found. They are heterogeneous type III and type II B, very numerous, extremely fine and extremely low to very low, with generally upright marginal cells. Parenchyma as such is absent. The fiber tracheids are septate or nonseptate and typically contain a nucleus (Plate 6, figs. 32, 33, 35, and 36). They are very short, very thin to thick-walled, and with bordered pit pairs usually. In general, one may say that in the members of the Asiatic sections the fiber tracheids are septate, with nuclei; the Mediterranean sections lack septations but have nuclei; the American sections are nonseptate and without nuclei. However, too many exceptions occur to make this statement as a general rule. Spiral thickenings are particularly well developed in the South American members of the section *Brathys* (Plate 6, fig. 34).

In considering the phylogenetic tree as proposed by Reuter(98) and others, from the sero-diagnostic technic, the writer and E. C. Abbe, under the guidance of Dr. K. S. Chester,(21) carried out a series of "precipitin reactions" in an attempt to test its application to plant relations. Within the ten species of *Hypericum* tested, the precipitation-reaction technic proved of no value in the segregation of species, but showed only homogeneity.

The genus *Ascyrum* is separated from *Hypericum* in being tetramerous (the author has observed many reversions to the pentamerous condition). R. Keller considers the separation of this genus as purely an artificial one. Certainly in the minute anatomy the species differ not at all from the members of *Hypericum.*

Brandza,(12) in considering the germination of the Hypericaceæ and Guttiferæ, finds that the embryo in the Hypericaceæ is like that in the tribe Clusieæ of the Guttiferæ, in having very small cotyledons, a large hypocotyl which elongates on germination, and a radicle which becomes the primary root of the plant.

The above consideration shows the genus *Hypericum* to be a very homogeneous one, the main variations occurring in the flower.

Included in the Hypericaceæ are a number of tropical genera (*Cratoxylon, Eliaea, Vismia, Psorospermum,* and *Haronga*). In an attempt to find the possible origin of the genus *Hypericum,* these genera were next examined. The tribes Cratoxyleæ and Vismeæ are separated with difficulty from the tribe Hypericaceæ. They differ mainly in being tropical trees with a 3- to 5-locular ovary and in having an embryo with cotyledons longer than the hypocotyl.

In their minute anatomy they differ in having (*a*) larger vessel elements (probably due to greater age), which are slightly oblique porous, and have alternate side-wall pitting (Plate 6, fig. 31); (*b*) the presence of parenchyma (vasicentric to confluent to metatracheal); and (*c*) nonseptate fibers with generally bordered pit pairs.

Guttiferæ.—Since the Hypericaceæ are usually placed in or near the Guttiferæ (text fig. 1), this group was next examined. In general, the morphological characters of the Guttiferæ differ but little from those of the Hypericaceæ, which are usually included or near the Guttiferæ. The Guttiferæ vary chiefly in being trees or shrubs, having leaves with lines of secretory canals and very numerous lateral nerves, and with stigmas sessile or subsessile. In floral characters and in the disposition of secretory canals they stand very near each other.

In their minute anatomy, except in the tribe Clusieæ, the Guttiferæ do not differ from the arborescent members of the Hypericaceæ. In this tribe the vessel member is slightly oblique to transverse porous (occasionally scalariform) but with opposite pitting on the tangential walls and with scalariform pitting on the radial walls; also, most of the members have septate fiber tracheids (Plate 3, fig. 18), and the rays are of a primitive type. Parenchyma is present in all members.

Brandza's(12) work on the embryo and its mode of germination, in this group, reveals some very striking variations. The tribe Clusieæ has an embryo with small cotyledons, an enlarged hypocotyl, and the radicle develops into the primary root. Germination is epigean (this was also true in *Hypericum*). In the Moronoboideæ and Garcinieæ the cotyledons are extremely small, the hypocotyl is enlarged, but the radicle develops but little and the main root is an adventitious root arising just below the cotyledons. Germination is hypogean. In the Calophylloideæ the embryo possesses large swollen cotyledons, a small swollen hypocotyl, and a well-developed radicle. The germination is hypogean.

These two families are obviously closely related. For convenience they might well be kept separate, yet, on the basis of the available evidence, they may be considered a part of the same family, as has been done by Engler, Wettstein, and others. Weill(123) relates the two groups through the subfamily Moronoboideæ of the Guttiferæ. Hochreutiner(54) combines the two

groups through *Psorospermum* and the subfamilies Calophylloideæ and Clusioideæ of the Guttiferæ. On the basis of minute anatomy and embryo structure, the writer believes this view of Hochreutiner to be correct, with *Hypericum* and its near relatives departing from the Clusioideæ, and the arborescent Hypericaceæ from the Calophylloideæ.

The Guttiferæ show various relationships, but the strongest, according to most authors, is with the Theaceæ. Engler and Prantl even suggest a possible genetical relationship. The Eucryphiaceæ, the Quiinaceæ, and the Dipterocarpaceæ are usually included as related families (text fig. 1). Hutchinson(59) characterizes his Guttiferales as the "advanced hypogynous type of the Theales with opposite leaves, often gland-dotted or lined; stamens united into bundles; no endosperm; sepals always imbricate."

Theaceæ.—The Theaceæ are of a more generalized type than the preceding family, with a scanty development of endosperm, numerous stamens, free or shortly connate, and with spirally arranged simple leaves.

In their minute anatomy they are characterized by having vessel members generally long, with highly oblique end walls, and with scalariform perforations (Plate 2, figs. 9 and 10) the bars of which are without a border, or bordered at the ends only. Intervascular pitting is dominantly transitional-scalariform to opposite. The fiber tracheids are nonseptate, with bordered pit pairs usually in a single line on the sides of the elements (Plate 2, figs. 8 to 10). Rays are of the general primitive type. The tribes Bonnetieæ, Asteropeieæ, and Tetrameristeæ depart from this in possessing vessel members with slightly oblique porous end walls and alternate side-wall pitting. The fiber tracheids in these sections are nonseptate, mostly long and thick-walled, but with bordered pits (Plate 2, figs. 8 and 12; Plate 3, fig. 13).

These tribes are seen to occupy an unusual position within this family. The Bonnetieæ, according to Engler and Prantl, in various characters, occupy a special position under the Theaceæ, and show in their morphology a remarkable analogy to the Kielmeyeroideæ of the Guttiferæ (a group which in the system of Bentham and Hooker is a part of the tribe Bonnetieæ in the Theaceæ). They differ mainly in lacking the secretory organs of the Guttiferæ. Engler and Prantl suggest that perhaps this

group stands as a connecting link between the Theaceæ and the Guttiferæ. The anatomical evidence would seem to bear this out.

The tribe Asteropeieæ, with its monotypic genus *Asteropeia*. has been placed (*a*) as the transitional genus to the Chlænaceæ, (*b*) as an abnormal tribe of the Flacourtiaceæ near the genus *Homalium,* and (*c*) in the Linaceæ. In the opinion of Engler and Prantl the structure of the ovaries justifies its place in the Theaceæ, and they suggest it as intermediate between the Theaceæ and the Flacourtiaceæ. The writer is inclined to the belief that this tribe should remain as rather an unusual tribe of the Theaceæ. It differs strongly from the flacourtiaceous woods in the presence of abundant paratracheal parenchyma, rays with most of the cells horizontally elongate or homogeneous, and in the possession of nonseptate, thick-walled fiber tracheids. The Chlænaceæ and Linaceæ were not examined, so that no evidence is available at present as to the possible relationship of the Asteropeicæ with these groups.

The tribe Tetrameristeæ, with its monotypic genus *Tetramerista,* has been placed by some authors, with or without reservation, in the Ochnaceæ. Hallier places it as a tribe of the Marcgraviaceæ. This tribe differs from the Ochnaceæ, in lacking stipules, is tetramerous, with 4 stamens and with anthers united by a connective. The ovary is 4-parted with a basically attached ovule in each carpel. The fruit is 4-seeded, berrylike, with leathery exocarp and fleshy mesocarp. The stem lacks the cortical bundles of the Ochnaceæ, and no vestured pits were observed. In its minute anatomy this tribe resembles in all characters the Caryocaraceæ, except in ray type and the presence of crystals in the genus *Caryocar* (compare Plate 2, fig. 12, and Plate 3, fig. 16). In floral morphology this tribe is advanced over the Caryocaraceæ, but would seem to express the development of tendencies noted in the Caryocaraceæ; that is, ovary 4- or 8- to 20-celled, ovules solitary in each cell, ascending, fruit rather drupaceous with a woody endocarp, breaking into 1-seeded parts.

On the basis of this evidence the writer suggests that this tribe be transferred to an affinity with the Caryocaraceæ.

The Theaceæ (Ternstrœmiaceæ) as conceived by Bentham and Hooker (text fig. 1) contained a larger number of groups that are now generally regarded as representing distinct families. Thus the Quiinaceæ, Caryocaraceæ, Marcgraviaceæ, Actinidia-

ceæ, and Saurauiaceæ are all generally considered within the circle of affinities of the Theaceæ.

Quiinaceæ.—Bentham and Hooker consider the Quiinaceæ as a tribe of the Guttiferæ, but all the other writers separate them as a distinct family, with a position near the Guttiferæ (text fig. 1). They differ from the latter mainly in possessing stipules, stamens definite in number, and leaves simple or pinnately lobed. In their anatomy they are essentially distinguished from the Guttiferæ by the absence of schizogenous resin canals, by the occurrence of lysigenous mucilage canals, and by possessing heterogeneous type I rays. The writer considers this group as having a similar level of development to that of the Guttiferæ, but as taking their origin in the Theaceæ.

Caryocaraceæ.—The Caryocaraceæ differ from the Theaceæ mainly in having leaves digitately 3- to 5-foliolate instead of simple, and in having subperigynous stamens. In their minute anatomy they differ in having vessel members with slightly oblique, porous end walls (or occasionally scalariform) with intervascular pitting alternate. The fiber tracheids are thick-walled to very thick-walled and have simple or slightly bordered pit pairs. The suggested relationship of this group to the tribe Tetrameristeæ has been noted above.

Marcgraviaceæ.—The Marcgraviaceæ differ from the Theaceæ mainly in being generally climbing and epiphytic shrubs, sterile flowers of the inflorescence variously modified, and without endosperm. Anatomically the group is very heterogeneous, displaying in the vessel members the range of variation from very oblique, scalariform perforation plates and opposite side-wall pitting (*Norantea*), to a slightly oblique, porous end wall and alternate to coalescent side-wall pitting (*Marcgravia*) (Plate 3, figs. 14 and 15). The fiber tracheids are nonseptate in *Norantea*, septate in *Marcgravia* and *Souroubea*. All have bordered pit pairs. The rays are all heterogeneous type I. The genus *Norantea* possesses the anatomical characters that would seem to link this family very closely to the Theaceæ.

Actinidiaceæ and Saurauiaceæ.—The Actinidiaceæ and the Saurauiaceæ are very closely related, and by some authors considered as one family (text fig. 1). They differ from the Theaceæ in having versatile anthers and numerous small seeds with copious endosperm. In their anatomy they do not differ widely from the Theaceæ. The Actinidiaceæ are climbers, frequently having unisexual flowers, styles numerous and free.

The Saurauiaceæ are erect trees or shrubs, flowers mostly perfect, styles 3 to 5, free or connate at the base. In their anatomy the Actinidiaceæ have long vessels, a few porous perforate members, paratracheal parenchyma scattered, as contrasted with the Saurauiaceæ with very long to extremely long vessel members and with abundant diffuse parenchyma. The writer believes these two groups might well remain separated, although they are closely related to each other, to the Theaceæ, and to the Dilleniaceæ. These two families are generally placed as the transitional group between the Theales and the Dilleniaceæ.

Dilleniaceæ.—The Dilleniaceæ are considered by all the authors as representing a basic family in this whole series. Their affinity to the Magnoliaceæ is especially suggested by their frequently occurring spirocyclic perianth and by their indefinite hypogynous and sometimes free carpels. Bentham and Hooker even included this group in the Ranales. By the characters mentioned above they differ from the Actinidiaceæ, Saurauiaceæ, and Theaceæ. In their anatomy little difference is noted. The bars on the scalariform-perforate end walls are mostly completely bordered, the parenchyma is mostly diffuse, and the fiber tracheids are similar to those in the above families. The rays are in general of a slightly more primitive type.

The groups thus far considered form a good sequence, from both the taxonomic and the anatomical points of view (text fig. 3).

In any consideration of other families that have been allied to the Guttiferæ, one must treat of the Eucryphiaceæ.

Eucryphiaceæ.—The Eucryphiaceæ were placed by Bentham and Hooker in the Rosaceæ. Hutchinson considers them between the Hypericaceæ and the Guttiferæ in the order Guttiferales (text fig. 1). The other authors consider them as belonging in the same complex with the Guttiferæ. They differ from the Guttiferæ in possessing intrapetiolar stipules, endosperm, free stamens, and simple to compound leaves. In their anatomy they differ in possessing vessel members that are long to very long, with the end wall highly oblique, scalariform-perforate (Plate 7, fig. 40), or occasionally reticulate or porous end walls. The bars are bordered only at the ends. The intervascular pitting is transitional, scalariform to opposite (Plate 7, fig. 40). The parenchyma is mainly diffuse but becomes terminal near the growth rings. The fiber tracheids are nonseptate, thick-walled, with bordered pit pairs in single rows. They lack secretory

canals. The rays are of an advanced type (heterogeneous type II). From this description it will be seen that in their anatomy they are nearer to the Dilleniaceæ than to the Guttiferæ in all but the ray structure. On this basis and that of their geographical distribution they are considered an outgrowth of the Dilleniaceæ.

The Ochnaceæ and the Dipterocarpaceæ are included in this series by most authors (text fig. 1). Bentham and Hooker place the Ochnaceæ in the Geraniales and Hutchinson places the Ochnaceæ and Dipterocarpaceæ in his Theales.

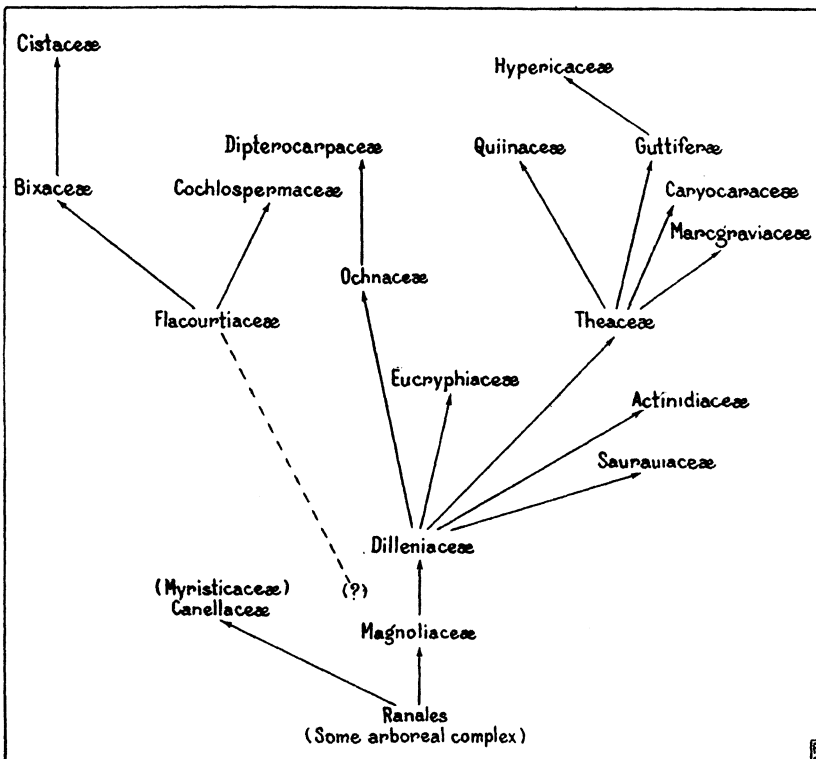


FIG. 3. Families of angiosperms.

Ochnaceæ.—The Ochnaceæ in *Ochna* and *Ouratea* possess a spirocyclic floral structure, characteristic of the Dilleniaceæ, but as in the Dilleniaceæ a reduction has occurred in the andrœcium and gynœcium. Also they possess stipules. Anatomically they differ greatly from the Dilleniaceæ in having vessel members short, with oblique porous end walls. The intervascular pitting

is alternate. The parenchyma is paratracheal, metatracheal, and diffuse, the metatracheal being most common in the genus *Lophira* (Plate 7, fig. 42; Plate 8, fig. 43). The fiber tracheids are nonseptate or septate, mostly thick-walled and long. The pit pairs are simple or slightly bordered. A common anatomical feature is the presence of leaf-trace bundles in the cortex (Rendle).

As has been mentioned in the description of this family, the two subfamilies Exalbuminosæ and Albuminosæ are separated on the basis of the presence or absence of endosperm. Anatomically they can be separated by the presence of vestured pits in the Exalbuminosæ, lacking in the Albuminosæ as shown by Bailey.(3) In the Albuminosæ the upright ray cells are more elongate, thus making the rays more heterogeneous (thus more primitive) than is found in the other tribe. Also we find septate fiber tracheids in certain of the Albuminosæ, as contrasted with their complete absence in the Exalbuminosæ.

The genus *Lophira* of the Exalbuminosæ seems to be something of a critical genus in the family, in that it combines characters of the Ochnaceæ with certain of those of the Dipterocarpaceæ. It differs from the latter in lacking resin canals, in the stratification of the bast that is characteristic in that family, and in ray type. It agrees in possessing two outer sepals that become much elongated in the fruit to form a wing, and in having vestured pits and well-developed metatracheal parenchyma. Bentham and Hooker consider *Lophira* to be a genus of the Dipterocarpaceæ. On the basis of similarity in floral structure and tendencies in the minute anatomy of the Exalbuminosæ, the writer feels that this genus may well be transitional to the Dipterocarpaceæ, though it be treated as belonging to the Ochnaceæ.

Dipterocarpaceæ.—The Dipterocarpaceæ differ from the preceding family in possessing a calyx that becomes enlarged and winglike in fruit (it is found in the Ochnaceæ only in the genus *Lophira*) and fruit mostly 1-seeded with endosperm lacking. Anatomically they differ in containing secretory canals in the xylem with metatracheal parenchyma well developed, and rays of a more advanced type. The writer believes this family stems in the Exalbuminosæ of the Ochnaceæ, with the connecting genus probably *Lophira*. The Dipterocarpaceæ and Ochnaceæ agree in lacking endosperm, in the presence of vestured pits, in the development of parenchyma, and in the presence of cortical bundles. Although the Dipterocarpaceæ have occasionally

been allied to the Guttiferæ due to the presence of the secretory canals, the writer regards the latter as a parallel development.

The families so far discussed seem to the author to be rather a homogeneous group, all stemming in the Dilleniaceæ (text fig. 3). There are variations in flowers, leaves, endosperm, and anatomy, but always in clearly defined lines. They are in agreement in having strongly developed parallel lateral veins in the leaf, widely imbricate calyx lobes, nutritive tissue of the seed containing oil and protein bodies, and generally axile placentation. In their anatomy the vessels vary from primitive to derived, but possess none of the highly evolved vessel types. The fiber tracheids vary in the same manner; even in the most highly developed groups in this series, one still finds slightly bordered pit pairs. In the vessel-to-ray pitting, most members still possess a half-bordered pit pair. Rays are with few exceptions heterogeneous and vary from primitive to derived.

Considered in this group or closely allied to it is the Parietales or Bixales complex. Since this group is considered in the line of origin of the Theales and Guttiferales of Hutchinson, the writer deems it desirable to consider them in the light of Hutchinson's position. This group contains, according to Hutchinson, the Bixaceæ, Cochlospermaceæ, Flacourtiaceæ, Canellaceæ, and Cistaceæ. Hutchinson characterizes them as " a woody to rarely subherbaceous group in which syncarpy with parietal placentation has remained a fixed character." As he considers them as stemming in the Dilleniaceæ, they will be considered in that light.

Bixaceæ.—The Bixaceæ differ from the Dilleniaceæ in having syncarpy, parietal placentation, anthers horseshoe-shaped, testa fleshy, leaves palmately lobed, and endosperm starchy. In their anatomy they differ in having vessel members short, slightly oblique to transverse porous (Plate 9, fig. 50); intervascular pitting alternate; wood parenchyma in strands 4 cells tall; fiber tracheids nonseptate, very thin-walled and very short, with bordered pit pairs rare; rays heterogeneous type II.

Cochlospermaceæ.—The Cochlospermaceæ differ from the preceding in having anthers straight or nearly so, and the fruit a 3- to 5-valved capsule. In the anatomy the vessel members are long (Plate 8, fig. 48); parenchyma paratracheal and with conspicuous metatracheal bands 5 to 8 cells wide.

Flacourtiaceæ.—The Flacourtiaceæ differ from the preceding two families in having stipules early deciduous, flower perfect, monœcious or diœcious, rarely polygamous, ovary superior to

inferior, 1-celled of 2 to 10 united carpels, and fruit indehiscent, mostly a berry or drupe, very rarely a capsule. In their anatomy they differ in having vessel members ranging from very long to very short. The end wall is typically porous, but scalariform perforation plates occur in several members of the lower tribes Oncobeæ and Pangieæ. Intervascular pitting is typically alternate, but here again the earlier two tribes Oncobeæ and Pangieæ possess transitional pitting. Parenchyma is typically absent, and when present is scanty and paratracheal. Rays are of a generally more primitive type. The fiber tracheids are generally septate with thin walls and with simple or slightly bordered pit pairs. In members possessing the thick-walled fibers a definite concentric appearance is seen in transverse section.

This family is seen to possess a wide range of varying structures. This leads the writer to believe that this more generalized family is more primitive than the preceding two. The tribes contained in this family are obviously related but possess tendencies in several directions. The anatomical evidence falls in line with the phylogenetic conclusions proposed by Engler and Prantl.

Cistaceæ.—The Cistaceæ, generally considered the most highly evolved of this group, differ from the previously discussed families in being a group of herbs and shrubs with generally opposite leaves, petals fugaceous, sepals contorted, seeds with bent, coiled, or folded embryo. In their anatomy they differ in lacking parenchyma (like the Flacourtiaceæ), having very inconspicuous rays, the fiber tracheids nonseptate and very short (Plate 9, fig. 51).

The Cistaceæ have been considered as closely related to the Hypericaceæ [Turner(117)], but the writer sees them rather as two end lines of parallel series at the same level of development. They seem to stand nearest to the Bixaceæ, which in turn stem in the Flacourtiaceæ. The Cochlospermaceæ seem to be a parallel development also arising in the Flacourtiaceæ.

This complex of families seems to be a line completely apart from the previously discussed series. It is even doubtful whether they take their origin in the same group. The Flacourtiaceæ are the only ones that show in their anatomy any relationship to the Dilleniaceæ, and Wettstein's idea that they stem in the Rhoeadales should be considered before a definite statement can be made.

Hutchinson's consideration of this group as basic for the Theales and Guttiferales should be disregarded. It is rather

difficult to conceive of the obviously primitive vessel members in the Theaceæ, Actinidiaceæ, and Saurauiaceæ as coming from the highly evolved vessel members of the Bixales series. The same is true regarding the ray types in the two series.

This whole series differs from the preceding series in having parietal placentation as a fixed character, in possessing stipules (also present in a few families of the other series), in having leaves palmately veined or without prominent parallel lateral veins, sepals slightly imbricate to valvate, endosperm copious and starchy, vessel members and ray type generally of an advanced type, fiber tracheids generally thin with only slightly bordered pit pairs.

Canellaceæ.—The family Canellaceæ is placed in this series by Bentham and Hooker, Hutchinson, and Engler and Prantl, but by Wettstein and Bessey is considered as belonging to the Polycarpicæ or Ranales along with the Magnoliaceæ (text fig. 1). It seems to occupy an unusual position from both the taxonomic and the anatomical point of view. Morphologically they are characterized as bisexual, cyclic, oligomerous, syncarpous, oligocarpous, endosperm oily and fleshy, embryo straight and very small, stamens few(20) and connate, leaves spiral and simple with stipules lacking. Anatomically the vessel members are mostly very long, end wall highly oblique, scalariform perforation plate, with crossbars completely bordered or bordered at the end to the middle. The intervascular pitting is transitional to opposite. The parenchyma is asymmetrically paratracheal, occurring on one side of the vessel members only (Plate 9, fig. 52), or occasionally diffuse. The rays are homogenous types I and III, mostly type III (Plate 9, figs. 53 and 54). The fiber tracheids are nonseptate with thin or thick walls, and have well-developed bordered pit pairs.

Gilg in Engler and Prantl states that on the presence of oil glands in the cortex, pith, and leaves, the character of the minute anatomy of the stem and the irregular number and spiral arrangement of petals in *Cinnamodendron* show relationship to the Magnoliaceæ. He further states that in the disposition of oil glands and in the coalescence of stamens, this group stands near the Myristicaceæ. Wettstein places the Canellaceæ as a family of the Polycarpicæ, next to the Myristicaceæ. Gilg, however, despite the other relationships that he mentions, believes this group to be a parallel development with the Fla-

courtiaceæ from a ranalian source and thus includes them in the Parietales.

The evidence presented shows that this family does not fit in either of the lines presented. It differs from the Parietales complex, where it has been most generally placed, in lacking stipules, having few stamens which are connate, and in possessing oily endosperm. In its minute anatomy it differs in all the characters noted above.

Concerning its relation to the Myristicaceæ, it has been noted that in the disposition of oil glands and coalescence of stamens this family shows relationship. Further points in its favor are the oily endosperm, small straight embryo, reduced number of sepals, petals, and stamens, and short style. In the minute anatomy of the Myristicaceæ as reported by Garratt(41) the scalariform type of vessel was found in all woods examined, although rare in some, intervascular pitting was alternate or opposite, though in some cases showing a more or less pronounced scalariform arrangement. The fiber tracheids have walls generally thin to very thin, with slightly bordered or simple pit pairs. The rays are usually distinctly heterogeneous, but are weakly heterogeneous to even homogeneous in some cases. Garratt,(42) although not relating the two groups closely, states that they do have definite characters in common.

It seems to the writer that this family, on all the available evidence, should be taken out of the Parietales-Guttiferales complex and placed near the Myristicaceæ as Wettstein and Bessey have done.

Magnoliaceæ.—Since the Magnoliaceæ are generally considered as the source of these groups, they will be characterized briefly. They are trees and shrubs, having perfect, cyclic, polymerous apocarpic flowers, large stipules, simple leaves, the stamens numerous and free, and the endosperm oily and copious. In their anatomy [McLaughlin(73) and checked by the writer] the vessel members are generally long with a highly oblique scalariform perforation with few to numerous bars. The intervascular pitting is transitional to scalariform, rarely opposite. The fiber tracheids are short to very long, tapering gradually to a point, and have circular bordered pit pairs with slitlike apertures. These characters on the basis of the dicta set forth page 225 show this group to be very primitive, as has been considered by a great many authors.

III. ADDITIONAL OBSERVATIONS

These observations,[5] outside of the secondary vascular anatomy, are given as additional supportive evidence of the phylogenetic lines as seen by the writer.

(*a*) *Spicular cells.*—Spicular cells in the mesophyll are always present in the Theaceæ, but are also found in the Dilleniaceæ, Guttiferæ, Ochnaceæ, Dipterocarpaceæ, and Flacourtiaceæ. They are generally of specific value only. In the above it will be noted that they occur in one major line of development, except for the Flacourtiaceæ, which are considered basal in the other line.

(*b*) *Secretory tissue.*—The presence of secretory cavities and canals has long been used as a taxonomic character. This character is variable in nature, content, and position. In the groups discussed, it occurs as characteristic of the Guttiferæ, Hypericaceæ, and Dipterocarpaceæ. Large, thin-walled oil or resin cells are found in the families Magnoliaceæ, Canellaceæ, Myristicaceæ, and others of that complex.

(*c*) *Cortical vascular bundles.*—The presence of cortical vascular bundles with a collateral structure may not always be of phylogenetic importance in the broadest sense, but may be used to show affinities within a restricted group. In the above-treated families this character is universally distributed in the Ochnaceæ and Dipterocarpaceæ.

(*d*) *Bast.*—Although not a great deal is known of bast structure, the presence of alternating layers of hard and soft bast may well show definite relationship within a large series. In the present group of families, alternating hard and soft bast is reported in the Magnoliaceæ, Dilleniaceæ, Canellaceæ, Bixaceæ, Cochlospermaceæ, Theaceæ, Guttiferæ, Ochnaceæ, and Dipterocarpaceæ.

(*e*) *Sero-diagnostic technic.*—Reuter,(98) in developing the phylogeny of the Parietales, places the Dilleniaceæ as a short branch from the main stem; next above he places a branch containing as lateral branches the Ochnaceæ, Hypericaceæ, Caryocaraceæ, Theaceæ, Bixaceæ, and Cistaceæ; above this as separate branches from the main stem appear the Canellaceæ and Dipterocarpaceæ. The Flacourtiaceæ are considered as on the main

[5] Unless otherwise stated, these observations are taken from Solereder.(104)

line above these families. The writer's observations on the members of the genus *Hypericum* [Chester, Abbe, and Vestal (21)], showed only homogeneity. The above results of Reuter are not in accord with the writer's disposition of these families (text fig. 3). It is introduced here as an interesting arrangement of this complex.

(*f*) *Nodal anatomy.*—Sinnott (101) gives the following lacunar condition in the families considered in this work: Dilleniaceæ, 3; Actinidiaceæ, 1; Saurauiaceæ, 1; Theaceæ, 1; Marcgraviaceæ, 1; Caryocaraceæ (not given); Guttiferæ, 1; Hypericaceæ, 1 (author's observation); Quiinaceæ (not given); Eucryphiaceæ, 3; Ochnaceæ, 3; Dipterocarpaceæ, 3 and 5; Flacourtiaceæ, 3; Cochlospermaceæ (not given); Bixaceæ, 3; Cistaceæ, 1; Canellaceæ (not given); Magnoliaceæ, 1 to 3 and many.

In this study the trilacunar condition is brought forward as the most primitive condition in the angiosperms. In using the node as an aid in the classification of the angiosperms, it will be noted that the Dilleniaceæ-Theaceæ line has a trilacunar to unilacunar condition; the Dilleniaceæ-Eucryphiaceæ-Ochnaceæ-Dipterocarpaceæ line is trilacunar, except that the Dipterocarpaceæ may also possess five. The Flacourtiaceæ-Bixaceæ-Cistaceæ line is seen to have a tri-, tri- to a unilacunar series. The Magnoliaceæ, considered a basic family, have a uni-, tri-, to many-lacunar condition.

CONCLUSIONS

The proposed phylogenetic sequence of the families studied is graphically summarized in text fig. 3. Text figure 3 is meant to show only the writers' phylogenetic conception of these groups at the present time. It is not meant to be a final disposition of these families. Additional evidence, particularly cytological, may do much in aiding a more final arrangement of this complex.

The anatomical method, while not final, certainly points to levels of development that are very important in the arrangement of a natural sequence. Definite anatomical trends and occasionally specific characters, if taken within a broad complex, aid in clearing the way for a more orderly arrangement of the families. Within a family the slight heterogeneity in the anatomy may be misleading, unless its phylogenetic background is known. Also, in comparing isolated families, homogeneity may indicate a level of development, rather than true relationship. To find the anwser, an inclusive study of allied families must be made.

The series of families examined seems to fall logically into two large complexes, the Parietales and Guttiferales of Wettstein (text figs. 1 and 3). The order Parietales, defined by Engler and Prantl as heterogeneous, proves to be such both on the basis of general morphology and secondary vascular anatomy. The subseries Theineæ within this order proves more homogeneous, but is probably composed of various lines coming from the Dilleniaceæ and Theaceæ (compare text figs. 1 and 3). It is a matter of opinion whether these should be segregated as separate orders as Wettstein and others have done or kept as a subseries of the Parietales. However, due to the heterogeneity of the group Parietales, it is believed that the splitting of this large complex makes for a more homogeneous understanding of the order.

The Bixales of Hutchinson should not be considered as the point of origin of the Theales and Guttiferales on the basis of their secondary anatomy. The line Dilleniaceæ to Theaceæ is a great deal more homogeneous when all the factors are considered.

In the writer's opinion, the Canellaceæ do not belong to this complex of families. It is suggested that this family could well be placed somewhere near the Myristicaceæ and the arboreal Ranales.

In general, Wettstein's treatment of these families is more in accord with the author's findings than any of the other systems considered.

SUMMARY

From this broad study certain salient facts stand out.

1. Vascular anatomy may be of use as a taxonomic tool, especially within large complexes in indicating levels of development, and in the disposition of certain debatable groups.

2. Correlations between dimensions, perforation plates and pitting of vessel members, pitting and dimensions of fiber tracheids, and the type of rays, prove to be of particular phyletic import in this study.

3. The groups logically fall into two major complexes, nearer the taxonomic treatment of Wettstein; namely, the Parietales and the Guttiferales, or that of Engler and Prantl's Parietales with its attendant subseries. The former is preferred. The treatment of Hutchinson does not fall in line with the observed anatomical evidence.

4. The Dilleniaceæ, Theaceæ, and Flacourtiaceæ are considered as possible groups within the complex from which the other lines have radiated.

5. The Canellaceæ are considered as being more closely related to the Myristicaceæ and the arboreal Ranales than to the above groups.

6. The Hypericaceæ on all available evidence would seem to be a logical outgrowth from the Guttiferæ. It is a matter of personal opinion whether the group should remain as a part of the Guttiferæ or be considered as a separate family.

REFERENCES

1. ARBER, E. A. N., and J. PARKIN. On the origin of angiosperms. Journ. Linn. Soc. Bot. **38** (1907) 29–80.
2. BAILEY, I. W. The rôle of the microscope in the identification and classification of the "Timbers of Commerce." Journ. Forestry **51** (2) (1917) 11–13.
3. BAILEY, I. W. The cambium and its derivative tissues. VIII. Structure, distribution, and diagnostic significance of vestured pits in dicotyledons. Journ. Arnold Arboretum **14** (1933) 259–273.
4. BAILEY, I. W., and ANNA F. FAULL. The cambium and its derivative tissues. IX. Structural variability in the redwood, Sequoia sempervirens, and its significance in the identification of fossil woods. Journ. Arnold Arboretum **15** (1934) 233–254.
5. BAILEY, I. W., and W. W. TUPPER. Size variation in tracheary cells: I. A comparison between the secondary xylems of vascular cryptogams, gymnosperms, and angiosperms. Proc. Am. Acad. Arts & Sci. **54** (1918) 149–204.
6. BENTHAM, GEORGE, and J. D. HOOKER. Genera plantarum. Reeve & Co., London **1** (1862–1867).
7. BESSEY, CHARLES E. The phylogeny and taxonomy of angiosperms. Bot. Gaz. **24** (1897) 145–178.
8. BESSEY, CHARLES E. A synopsis of plant phyla. University Studies **7** (1907) 1–99.
9. BESSEY, CHARLES E. The phylogenetic taxonomy of flowering plants. Ann. Missouri Bot. Gard. **2** (1915) 109–164.
10. BEWS, J. W. Studies in the ecological evolution of angiosperms. New Phyt. **26** (1927) 1–21, 65–84, 129–148, 209–248, 273–294.
11. BLENK, PAUL. Hypericaceae. Flora **67** (1884) 111, 112, 136–144, 204, 205.
12. BRANDZA, G. Recherches anatomiques sur la germination des Hypéricacées et des Guttifères. Ann. des Sci. Nat. IX **8** (1909) 221–300.
13. BROWN, F. B. H. Scalariform pitting a primitive feature in angiospermous secondary wood. Science n. s. **48** (1918) 16–18.
14. CAMBESSEDES, J. Mémoire sur les familles des Ternstroemiacées et des Guttifères. Mem. Mus. Hist. Nat. **16** (1828).
15. CHALK, L. The formation of spring and summer wood in ash and douglas fir. Oxford Forestry Memoirs No. **10** (1930) 7–44.

16. CHALK, L. Tracheid length, with special reference to Sitka spruce (Picea sitchensis Carr.) Forestry 4 (1) (1930) 7–14.
17. CHALK, L., and M. M. CHATTAWAY. Measuring the length of vessel members. Tropical Woods 40 (1934) 19–26.
18. CHALK, L., and M. M. CHATTAWAY. Factors affecting dimensional variations of vessel members. Tropical Woods 41 (1935) 17–37.
19. CHATTAWAY, M. M. Note on the chromosomes of the genus Hypericum, with special reference to chromosome size in H. calycinum. Brit. Journ. Exp. Biol. 3 (2) (1926) 141–143. 1 fig.
20. CHATTAWAY, M. M. Proposed standards for numerical values used in describing woods. Tropical Woods 29 (1932) 20–28.
21. CHESTER, K. S., E. C. ABBE, and P. A. VESTAL. Studies on the "precipitin reaction" in plants. V. Application to plant relationships. Journ. Arnold Arboretum 14 (1933) 394–407.
22. CHOISY, J. D. D'une monographie de la famille des Hypéricinées. Genève–Paris (1821) 1–70.
23. CHOISY, J. D. Mémoire sur un nouveau genre de Guttifères et sur l'arrangement methodique de cette famille. Soc. Hist. Nat. Paris Mém. 1 (1823) 210–232.
24. CLARK, S. H. Home grown timbers; their anatomical structure, and its relation to physical properties. Elm. Dept. of Scientific and Industrial Research. F. P. R. Bull. No. 7. H. M. Stationery Office (1930).
25. CLOS, DOMINIQUE. Des glandes dans le genre Hypericum. Acad. Sci. Toulouse Mém. VI 6 (1868) 257–266.
26. Committee on Nomenclature, International Association of Wood Anatomists. Glossary of Terms used in describing woods. Tropical Woods 36 (1933) 1–12.
27. COULTER, J. M. Revision of North American Hypericaceae. Bot. Gaz. 11 (1886) 78–88, 106–112, 275, 276.
28. DESCH, H. E. Significance of numerical values for cell dimensions. Tropical Woods 29 (1932) 14–20.
29. DESCH, H. E. Anatomical variation in the wood of some dicotyledonous trees. New Phyt. 31 (1932) 6–118.
30. DESMIDT, W. J. Studies in the distribution and volume of the wood rays of slippery elm (Ulmus fulva Michx.). Journ. Forestry 20 (1922) 352–362.
31. EAMES, A. J. On the origin of the herbaceous habit in angiosperms. Ann. Bot 25 (1911) 215–224.
32. ENGLER, A., and K. PRANTL. Die natürlichen Pflanzenfamilien, Leipzig 21 (1925).
33. EYMA, P. J. The Polygonaceae, Guttiferae and Lecythidaceae of Surinam. J. H. de Bussy, Amsterdam (1932).
34. FAWCETT, WILLIAM, and A. B. RENDLE. Notes of Jamaica plants. Journ. Bot. 60 (1922) 361–363.
35. FRITSCH, F. E. The use of anatomical characters for systematic purposes. New Phyt. 2 (1903) 177–184.
36. FOXWORTHY, F. W. Philippine Dipterocarpaceae, I. Philip. Journ. Sci. § C 6 (1911) 231–287.
37. FOXWORTHY, F. W. Philippine Dipterocarpaceae, II. Philip. Journ. Sci. § C 13 (1918) 163–199.

38. FROST, FREDERICK H. Specialization in secondary xylem of dicots. I. Origin of vessel. Bot. Gaz. **89** (1930) 67–94.

39. FROST, FREDERICK H. Specialization in secondary xylem of dicots. II. Evolution of end wall of vessel segments. Bot. Gaz. **90** (1930) 198–212.

40. FROST, FREDERICK H. Specialization in secondary xylem of dicots. III. Specialization of lateral wall of vessel segments. Bot. Gaz. **91** (1931) 88–96.

41. GARRATT, C. A. Systematic anatomy of the woods of the Myristicaceae. Tropical Woods **35** (1933) 6–48.

42. GARRATT, C. A. Bearing of wood anatomy on the relationships of Myristicaceae. Tropical Woods **36** (1933) 20–44.

43. GREEN, J. R. On the organs of secretion in the Hypericaceae. Linn. Soc. Journ. Bot. **20** (1884) 451–464.

44. HALL, H. M., and F. E. CLEMENTS. The phylogenetic method in taxonomy. Carnegie Inst. Wash. No. **326** (1923) 1–30.

45. HALLIER, HANS. Provisional scheme of the natural (phylogenetic) system of flowering plants. New Phyt. **4** (1905) 151–162.

46. HALLIER, HANS. L'origine et le systeme phylétique des angiosperms. Arch. Néerl. d. Sc. exact. et natur. Publ. Soc. Holl. Sc. Harlem IIIB, **1** (1912) 146–234.

47. HAYATA, B. The natural classification of plants according to the dynamic system. Icones Plant. Formos. **10** (1921) 97–234.

48. HECKEL, E. Sur la formation des canaux sécréteurs dans les graines de quelques Guttifères. Compt. rendu. **129** (1889) 508–510.

49. HITZEMANN, KARL. Beiträge zur vergleichenden Anatomie der Ternstroemiaceen, Dilleniaceen, Dipterocarpaceen und Chlenaceen. Asterode a. H. (1886) 1–97.

50. HOAR, CARL SHERMAN. Meiosis in Hypericum punctatum. Bot. Gaz. **92** (1931) 396–406.

51. HOAR, CARL SHERMAN, and EDWIN JACOB HAERTL. Meiosis in the genus Hypericum. Bot. Gaz. **93** (1932) 197–204.

52. HOCHREUTINER, B. P. G. La fonction lodiculaire des corpuscules chez les Guttifères. Compt. rendu des Séances de la Soc. Phys. & Hist. Nat. Genève **35** (1918) 82–85.

53. HOCHREUTINER, B. P. G. Guttiferae novae vel minus cognitae. Ann. Conserv. & Gard. Bot. Genève **21** (1919) 49–68.

54. HOCHREUTINER, B. P. G. La parenté des Guttifères et des Hypéricenées. Compt. rendu de Séances de la Soc. Phys. & Hist. Nat. Genève **36** (1919) 26, 27.

55. HOCHREUTINER, B. P. G. Sur les relations de parenté des Guttifères avec d'autres familles végétales. Compt. rendu de Séances de la Soc. Phys. & Hist. Nat. Genève **36** (1919) 62–67.

56. HOFMEISTER, W. Allgemeine Morphologie der Gewächse. Leipzig (1869).

57. HÖHNEL, FRANZ VON. Ueber Harzröhren und Harzschläuche bei Hypericum und Androsaemum. Bot. Zeit. **40** (1882) 149–152.

58. HOLM, THEO. Triadenum virginicum (L.) Rafin. A morphological and anatomical study. Am. Journ. Sc. **16** (1903) 369–376.

59. HUTCHINSON, J. The families of flowering plants. I. Dicotyledons. Macmillan & Co., London (1926).
60. JEFFREY, E. C. Anatomy of woody plants. University of Chicago Press, Chicago (1917).
61. JEFFREY, E. C. Technical contributions. Bot. Gaz. **86** (1928) 456.
62. JOHNSON, A. M. Taxonomy of the flowering plants. The Century Company (1931).
63. JONES, W. S. Timbers, their structure and identification. Oxford, Clarendon Press (1924) 1–148.
64. JUSSIEU, A. L. Sur les caractères generaux des familles tirés des graines Hypéricées, Guttifères. Ann. du Mus. **20** (1813) 459–469.
65. KANEHIRA, R. Anatomical characters and identification of Formosan woods. Bureau Prod. Ind. Gov. Formosa (Taihoku) (1921) 1–317.
66. KANEHIRA, R. Identification of Philippine woods by anatomical characters. Gov. Research Inst. Formosa (Taihoku) (1921) 1–73.
67. KANEHIRA, R. Identification of important Japanese woods by anatomical characters. Bull. Prod. Inds. Gov. Formosa (Taihoku) (1921) 1–104.
68. KERNER, A., and F. W. OLIVER. The natural history of plants. Blackie & Son, Ltd., London **2** (1895) 584.
69. KIENAST, HERMANN. Ueber die Entwicklung der Oelbehälter in den Blättern von Hypericum und Ruta. Elbing (1885) 1–49.
70. KRIBS, DAVID A. Salient lines of structural specialization in the woody rays of dicotyledons. Bot. Gaz. **96** (1935) 547–557.
71. LECHNER, S. Anatomische Untersuchungen über die Gattung Actinidia, Saurauia, Clethra und Clematoclethra mit besonderer Berücksichtigung ihrer Stellung im System. Beihefte Bot. Centralbl. **32** (1914) 431–467.
72. LUBBOCK, JOHN. A contribution to our knowledge of seedlings. Kegan, Trench, Trübner & Co., Ltd., London (1892) 2 vols.
73. MCLAUGHLIN, ROBERT P. Systematic anatomy of the woods of the Magnoliales. Tropical Woods **34** (1933) 3–38.
74. MARSH, C. D., and A. B. CLAWSON. Toxic effect of St. Johnswort (Hypericum perforatum) in cattle and sheep. U. S. D. A. Tech. Bull. No. 202 (1930) 1–23.
75. MATSUDA, S. On the anatomy of Magnoliaceae. Journ. Col. Sci. Imp. Univ. Japan **6** (1894) 115–149.
76. MEZ, C., and K. GOHLKE. Physiologisch-systematische Untersuchungen über die Verwandtschaften der Angiosperme. Beitr. Biol. Pflanzen **12** (1913) 155–180.
77. MIERS, JOHN. Observations on the structure of the seed and peculiar form of the embryo in the Clusiaceae. Linn. Soc. **21** (1855) 243–258.
78. MIERS, JOHN. On the Canellaceae. Ann. & Mag. Nat. Hist. London (1858).
79. MÖLL and JANSSONIUS. Mikrographie des Holzes der auf Java vorkommenden Baumarten. Heft 1, Leyden (1906) 1–368.
80. MÖLLER, J. Beiträge zur vergleichenden Anatomie des Holzes. Denkschr. der K. Ac. d. Wiss. Wien **36** (1876) 297–426.

81. MÜLLER, K. Vergleichende Untersuchung der anatomischen Verhältnisse der Clusiaceen, Hypericaceen, Dipterocarpaceen und Ternstroemiaceen. Botanische Jahrbücher für Systematik 2 (1882) 430–464.

82. MYER, J. E. Ray volumes of the commercial wood of the United States and their significance. Journ. Forestry 20 (1922) 337–351.

83. NIELSEN, NIELS. Chromosome numbers in the genus Hypericum. Hereditas 5 (1924) 378–382.

84. NOACK, K. L. Ueber Hypericum-Kreuzungen. III. Rassen- und Artkreuzungen mit einen buntblättrigen Hypericum acutum. Zeitschr. Indukt. Abstamm. u. Vererbungsl. 63 (1932) 232–235.

85. PAYER, J. B. Familles des Hypéricenées (Androsaemum, Hypericum, Eremanthe, Elodea, Myriandra) et des Dilléniacées (Hibbertia, Candollea). Acad. Sci. Paris. Compt. Rend. 37 (1853) 589–593.

86. PEARSON, R. S., and H. P. BROWN. Commercial timbers of India. Gov. of India Central Publication Branch, Calcutta (1932) 2 vols., 1150 pp.

87. PLANCHON, J. E., and J. TRIANA. Mémoire sur la famille des Guttifères. Ann. Sci. Nat. Bot. 13 (1860) 306–376; 14 (1860) 226–367; 15 (1861) 240–319; 16 (1861) 263–308.

88. PLANCHON, J. E., and J. TRIANA. Sur la famille des Guttifères. Bull. Soc. Bot. France 8 (1861) 26–29, 66–73, 96–100.

89. PLANCHON, J. E., and J. TRIANA. Etudes sur la famille des Guttifères. Compt. rendu. Acad. Sci. Paris 52 (1861) 132–135.

90. PRICHARD, R., and I. W. BAILEY. The significance of certain variations in the anatomical structure of wood. Forest. Quarterly 14 (1916) 662–670.

91. RECORD, SAMUEL J. Timbers of tropical America. Yale Univ. Press, New Haven (1924) 610 pp.

92. RECORD, SAMUEL J. Identification of the timbers of temperate North America. John Wiley & Sons, Inc., New York (1934).

93. RECORD, SAMUEL, J. Rôle of wood anatomy in taxonomy. Tropical Woods 37 (1934) 1–9.

94. RENDLE, A. B. The classification of flowering plants. Cambridge, England 2 (1925).

95. RENDLE, B. J. Wood anatomy as a link between botany and forestry. Nature 130 (1932) 834–836.

96. RENDLE, B. J., and S. H. CLARKE. The problem of variation in the structure of wood. Tropical Woods 38 (1934) 1–8.

97. RENDLE, B. J., and S. H. CLARKE. The diagnostic value of measurements in wood anatomy. Tropical Woods 40 (1934) 27–37.

98. REUTER, KARL. Die Phylogenie der Parietales. Bot. Archiv 16 (1926) 118–217.

99. REYES, LUIS J. Fiber studies of Philippine dipterocarps. Journ. of Forestry 19 (1921) 97–104.

100. SIERSCH, E. Anatomie und Mikrochemie der Hypericum- Drüsen. Planta: Archiv für wissensch. Botanik 3 (1927) 481–489.

101. SINNOTT, E. W. Investigations on the phylogeny of the angiosperms. I. The anatomy of the node as an aid in the classification of angiosperms. Am. Journ. Bot. 1 (1914) 303–322.

102. SINNOTT, E. W., and I. W. BAILEY. Investigations on the phylogeny of the angiosperms. IV. The origin and dispersal of herbaceous angiosperms. Ann. Bot. **28** (1914) 547–600.

103. SOLEREDER, HANS. Über den systematischen Werth der Holzstructur bei den Dicotyledonen. München (1885) 1–264.

104. SOLEREDER, HANS. Systematic anatomy of the dicotyledons. Trans. Boodle and Fritsch. Clarendon Press, Oxford (1908).

105. SOUÈGES, RENÉ. Embryogénie des Hypéricacées développement de l'embryon chez l'Hypericum perforatum L. Compt. rend. Acad. Sci. Paris **180** (1925) 949–951.

106. SPACH, E. Conspectus monographiae Hypericacearum. Ann. Sci. Nat. Bot. **5** (1836) 157–176, 349–369.

107. SPRAGUE, T. A. Notes on Theaceae. Journ. Bot. **61** (1923) 17–19, 83–85.

108. SPRAGUE, T. A. The classification of dicots. A. I. General principles. Journ. Bot. **63** (1925) 9–13. B. II. Evolutionary progressions. Journ. Bot. **63** (1925) 105–113.

109. STANDLEY, P. C. Revision of some American species of Calophyllum. Tropical Woods **30** (1932) 6–9.

110. STEFANOFF, B. Sistematicheski i geografiski prouchvaniai vurkhu mediteranski-orientaliskitè vidove na roda Hypericum L. (Systematische und geographische Studien über die mediterran-orientalischen Arten der Gattung Hypericum L.) (Bulgarian with German summary and Latin diagnoses.) Jahrb. d. Land. u. Forstwiss. Fakultät d. Univ. Sofia **10** (1932) 19–63; **11** (1933) 139–186; **12** (1934) 69–100.

111. STEFANOFF, B. Die mediterran-orientalischen Arten der Gattung Hypericum L. Pflanzenareale IV Heft **1** (1933) 1–10.

112. THOMPSON, W. P. The relationship of the different types of angiospermic vessels. Ann. Bot. **37** (1923) 183–192.

113. TIEGHEM, PH. VAN. Sur la disposition des canaux sécréteurs dans les Clusiacées, des Hypéricacées, les Ternstroemiacées et les Dipterocarpacées. Soc. Bot. France Bull. **31** (1884) 141–148.

114. TIEGHEM, PH. VAN. Sur les Canellacées. Journ. de Bot. **13** (1899) 266–276.

115. TISCHLER, GEO. Pflanzliche Chromosomen-Zahlen. Tabulas Biblogicae **4** (1927).

116. TUPPER, W. W. Preliminary report on the wood structure of the Flacourtiaceae. Tropical Woods **38** (1934) 11–14.

117. TURNER, WILHELM. Beitrag zur vergleichenden Anatomie der Bixaceen, Samydaceen, Turneraceen, Cistaceen, Hypericaceen, und Passifloreen. Goettingen (1885) 1–75.

118. URSPRUNG, ALFRED. Beiträge zur Anatomie und Jahreringbildung tropischer Holzarten (Dissertation) Basil (1900).

119. VESQUE, J. Monographiae Phanerogamarum (Guttiferae). Sumptibus G. Masson, Paris **8** (1893) 1–669.

120. VESQUE, J. La tribu des Clusiées; résultats généraux d'une monographie morphologique et anatomique de ces plantés. Journ. Bot. Paris **5** (1891) 297–305, 322–330; **6** (1892) 81–90, 369–378, 396–404; **7** (1893) 14–19, 47–51, 66–72; **8** (1894) 183–196.

121. VESQUE, J. Guttiferae. Suites au Prodromis systematis naturalis regni vegetalis. H. & C. de Candolle, Paris, Monogr. Phan. 8 (1893).

122. WANSCHER, J. H. The basic chromosome number of the higher plants. New Phyt. 33 (1934) 101–126.

123. WEILL, GEO. Recherches histologiques sur la famille des Hypéricacées. Trav. Lab. Mat. Med. Ecole sup. Pharm. Paris 1 pt. 3 (1903) 1–189.

124. WEINSTEIN, A. I. Summary of literature relating to the volume, distribution, and effects of medullary rays in wood. Journ. Forestry 24 (1926) 915–925.

125. WERNHAM, H. F. Floral evolution. New Phyt. 10 (1911) 73, 100, 145, 217, 293; 11 (1912) 145, 217, 290, 376.

126. WETMORE, R. H. The use of celloidin in botanical technic. Stain Technology 7 (1932) 37–62.

127. WETTSTEIN, R. Handbuch der systematischen Botanik. 2d ed. Leipzig und Wien (1924).

ILLUSTRATIONS

These photomicrographs were made with a Bausch and Lomb J. camera, Bausch and Lomb photographic microscope with Zeiss apochromatic objectives, and, in the main, Zeiss Homal oculars.

The particular magnification used in making each picture is indicated with its description.

So far as is known, all the material was correctly identified, but the possibility of misidentification must not be left out of consideration, especially since these are all wood specimens and therefore difficult to check with herbarium material. The writer has not concerned himself with synonomy in specific names, as the main problem is centered around the family.

In the following photomicrographs the number of the slide is given. *R* following the number indicates that the material is from Prof. S. J. Record, *B* indicates the Prof. I. W. Bailey's collection, and *B. L.* indicates a slide in the Harvard Biological Laboratories collection.

PLATE 1

FIG. 1. *Dillenia Reifferschiedia* Spach. (3462 B), Dilleniaceæ. Transverse section, showing distribution of pores, fiber tracheids, and rays. × 45.

2. *Dillenia Reifferschiedia* Spach. (3462 B), Dilleniaceæ. Tangential section, showing multi- and uniseriate rays, pitting of fiber tracheids, and indication of vessel end wall. × 45.

3. *Dillenia luzoniensis* (Vid.) Merr. (4426 R), Dilleniaceæ. Section of vessel end wall, showing bordered scalariform bars, occluded with a tylosis. × 225.

4. *Schumacheria castaneifolia* Vahl. (2632J B), Dilleniaceæ. Radial section showing intervascular scalariform pitting. × 55.

5. *Saurauia submodesta* Diels. (4954 R), Saurauiaceæ. Radial section showing vessel end, intervascular pitting, palisade ray cells, and fiber-tracheid pitting. × 110.

6. *Saurauia nudiflora* DC. (1102 B), Saurauiaceæ. Tangential section showing multiseriate rays with upright sheath cells, uniseriate rays and fiber tracheids. × 100.

PLATE 2

FIG. 7. *Schima supera* Gord. (21868 R), Theaceæ. Transverse section showing a growth ring and distribution of pores and fiber tracheids. × 45.

FIG. 8. *Ploiarum alternifolium* (Vahl.) Melch. (15441 R), Theaceæ. Tangential section showing porous vessel ends, intervascular pitting, rays, and fiber tracheids. × 55.

9. *Schima supera* Gord. (21868 R), Theaceæ. Radial section showing vessel ends, fiber tracheids, and rays. × 100.

10. *Camellia japonica* L. var. *spondanea* Makins (14591 R), Theaceæ. Radial section showing vessel ends, intervascular pitting, and cluster pitting in parenchyma. × 100.

11. *Tetramerista glabra* Miquel (8223 R), Theaceæ. Transverse section showing distribution of pores, fiber tracheids, parenchyma, and rays. × 55.

12. *Tetramerista glabra* Miquel (8223 R), Theaceæ. Tangential section showing intervascular pitting, tyloses in end wall, rays, and fiber tracheids. × 55.

PLATE 3

FIG. 13. *Bonnetia tristyla* Gl. (16185 R), Theaceæ. Radial section showing vessel ends, fiber tracheids, and vessel-ray pitting. × 45.

14. *Marcgravia rectiflora* Tr. and Planch. (1379 R), Marcgraviaceæ. Radial section showing vessel end, intervascular pitting, and septate fiber tracheids. × 55.

15. *Souroubea quianensis* Aubl. (552 B), Marcgraviaceæ. Radial section showing vessel end, intravascular pitting, vessel-ray pitting, and fiber tracheids. × 55.

16. *Caryocar villosum* (Aubl.) Pers. (22576 R), Caryocaraceæ. Tangential section showing rays, fiber tracheids, and septate parenchyma containing crystals. × 83.

17. *Chrysochlamys membranacea* Planch. (20962 R), Guttiferæ. Transverse section showing distribution of elements. × 45.

18. *Chrysochlamys membranacea* Planch. (20962 R), Guttiferæ. Radial section showing scalariform intervascular pitting and septate fiber tracheids. × 100.

PLATE 4

FIG. 19. *Mammea americana* L. (2702 R), Guttiferæ. Transverse section showing distribution of elements. × 55.

20. *Allanblackia parviflora* A. Chev. (15232 R), Guttiferæ. Transverse section showing distribution of elements. × 45.

21. *Garcinia Mannii* Oliv. (15780 R), Guttiferæ. Transverse section showing distribution of elements. × 55.

22. *Calophyllum montanum* Vieill. (14226 R), Guttiferæ. Transverse section showing distribution of elements. × 45.

23. *Platonia insignis* Mart. (13615 R), Guttiferæ. Transverse section showing distribution of elements. × 45.

24. *Hypericum perforatum* L. (B. L.), Hypericaceæ. Transverse section showing distribution of elements. × 45.

PLATE 5

FIG. 25. *Garcinia corymbosa* Wall. (14025 R), Guttiferæ. Tangential section showing rays, fiber tracheids, vessel members, and parenchyma. × 45.

26. *Platonia insignis* Mart. (13615 R), Guttiferæ. Tangential section showing vessel members, rays, fiber tracheids, and parenchyma. × 55.

27. *Mammea americana* L. (2702 R), Guttiferæ. Tangential section showing secretory canals in the rays, and fiber-tracheid pitting. × 55.

28. *Calophyllum montanum* Vieill. (14426 R), Guttiferæ. Tangential section showing vessel members, rays, and fiber tracheids. × 45.

29. *Kayea assamica* Prain. (9587 R), Guttiferæ. Radial section showing vessel members, parenchyma, ray cells, and pitting of fiber tracheids. × 110.

30. *Caraipa* sp. (21335 R), Guttiferæ. Tangential section showing vessel members, rays, and fiber tracheids. × 45.

PLATE 6

FIG. 31. *Haronga madagascarensis* Choisy (11135 R), Hypericaceæ. Tangential section showing intervascular pitting, rays, and fiber tracheids. × 55.

32. *Hypericum adpressum* Bart. (B. L.), Hypericaceæ. Tangential section showing rays, septate fiber tracheids with nuclei, and vessel members. × 75.

33. *Hypericum Androsaemum* L. (B. L.), Hypericaceæ. Radial section showing vessel members, septate fiber tracheids with nuclei (some dividing), and ray cells. × 83.

34. *Hypericum chamaemyrtos* Trian. (B. L.), Hypericaceæ. Radial section showing vessel members with spiral thickenings, ray cells, and fiber tracheids. × 75.

35. *Hypericum atomarum* Boiss. (B. L.), Hypericaceæ. Radial section showing vessel members with types of perforation and fiber tracheids. × 75.

36. *Hypericum atomarum* Boiss. (B. L.), Hypericaceæ. Radial section showing types of vessel perforations and fiber tracheids with nuclei. × 75.

PLATE 7

FIG. 37. *Quiina Cruigeriana* Griseb. (1115 R), Quiinaceæ. Tangential section showing rays, fiber tracheids, and vessel members. × 55.

38. *Eucryphia Bittardieri* Spach. (19658 R), Eucryphiaceæ. Transverse section showing distribution of elements. × 45.

39. *Eucryphia Moorei* F. v. Müll. (19336 R), Eucryphiaceæ. Tangential section showing vessel members and fiber tracheids and rays. × 55.

FIG. 40. *Eucryphia Moorei* F. v. Müll. (19336 R), Eucryphiaceæ. Radial section showing vessel members and ray cells. × 55.

41. *Ouratea agrophylla* Urb. (16697 R), Ochnaceæ. Transverse section showing distribution of elements. × 45.

42. *Lophira alata* Banks (19764 R), Ochnaceæ. Transverse section showing distribution of elements. × 45.

PLATE 8

FIG. 43. *Lophira alata* Banks (19764 R), Ochnaceæ. Radial section showing parenchyma, fiber tracheids, vessel members, and ray cells. × 45.

44. *Ouratea agrophylla* Urb. (16697 R), Ochnaceæ. Tangential section showing rays, vessel members, intervascular pitting, and fiber tracheids. × 55.

45 *Elvasia* sp. (2100 R), Ochnaceæ. Tangential section showing vessel members, rays, parenchyma, and fiber tracheids. × 55.

46. *Dipterocarpus Dyerii* Pierre (13147 R), Dipterocarpaceæ. Transverse section showing distribution of elements. × 45.

47. *Dipterocarpus Dyerii* Pierre (13147 R), Dipterocarpaceæ. Tangential section showing rays and fiber tracheids. × 55.

48. *Cochlospermum vitifolium* (Willd.) Spreng. (277 B), Cochlospermaceæ. Tangential section showing vessel members with intervascular pitting, parenchyma, rays, and fiber tracheids. × 45.

PLATE 9

FIG. 49. *Bixa Orellana* L. (17294 R), Bixaceæ. Transverse section showing distribution of elements. × 55.

50. *Bixa Orellana* L. (17294 R), Bixaceæ. Tangential section showing storied arrangement of rays, vessel members, and parenchyma strands. × 55.

51. *Lechea maritima* Leggett (B. L.), Cistaceæ. Radial section showing vessel members, ray cells, and fiber tracheids. × 75.

52. *Capella Winterana* Gaertn. (23378 R), (Canellaceæ), Transverse section showing distribution of elements. × 83.

53. *Capsicodendron pimentiera* Hoche (23444 R), Canellaceæ. Radial section showing rays, parenchyma, and fiber tracheids. × 45.

54. *Canella Winterana* Gaertn. (23378 R), Canellaceæ. Tangential section showing rays (some cells with crystals) and fiber tracheids with pitting. × 83.

TEXT FIGURES

FIG. 1. Phylogenetic trends of angiosperms.

2. Variations in the genus *Hypericum*.

3. Families of angiosperms.

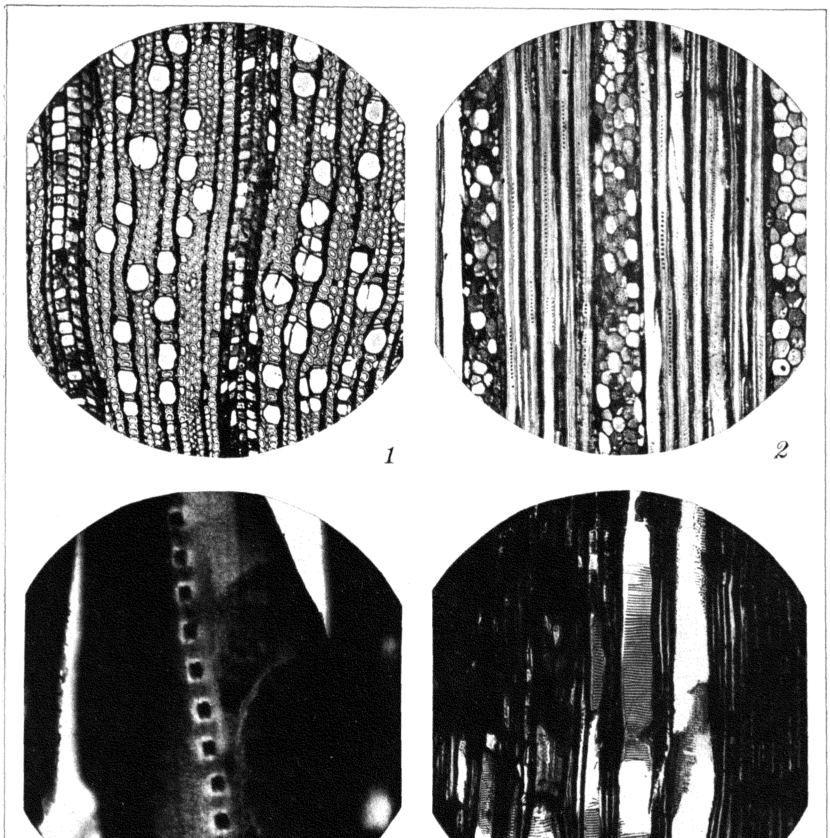
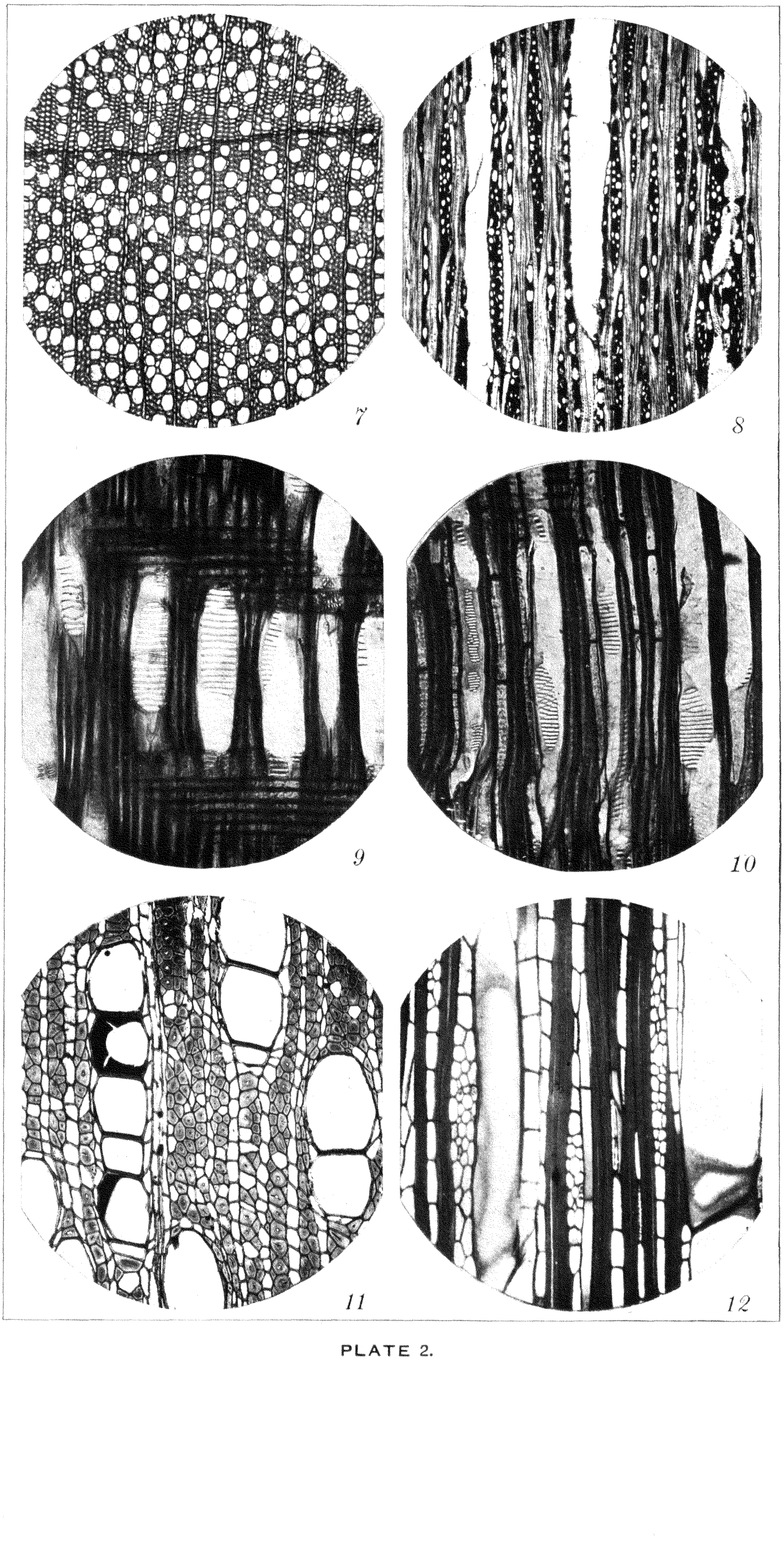


PLATE 1.



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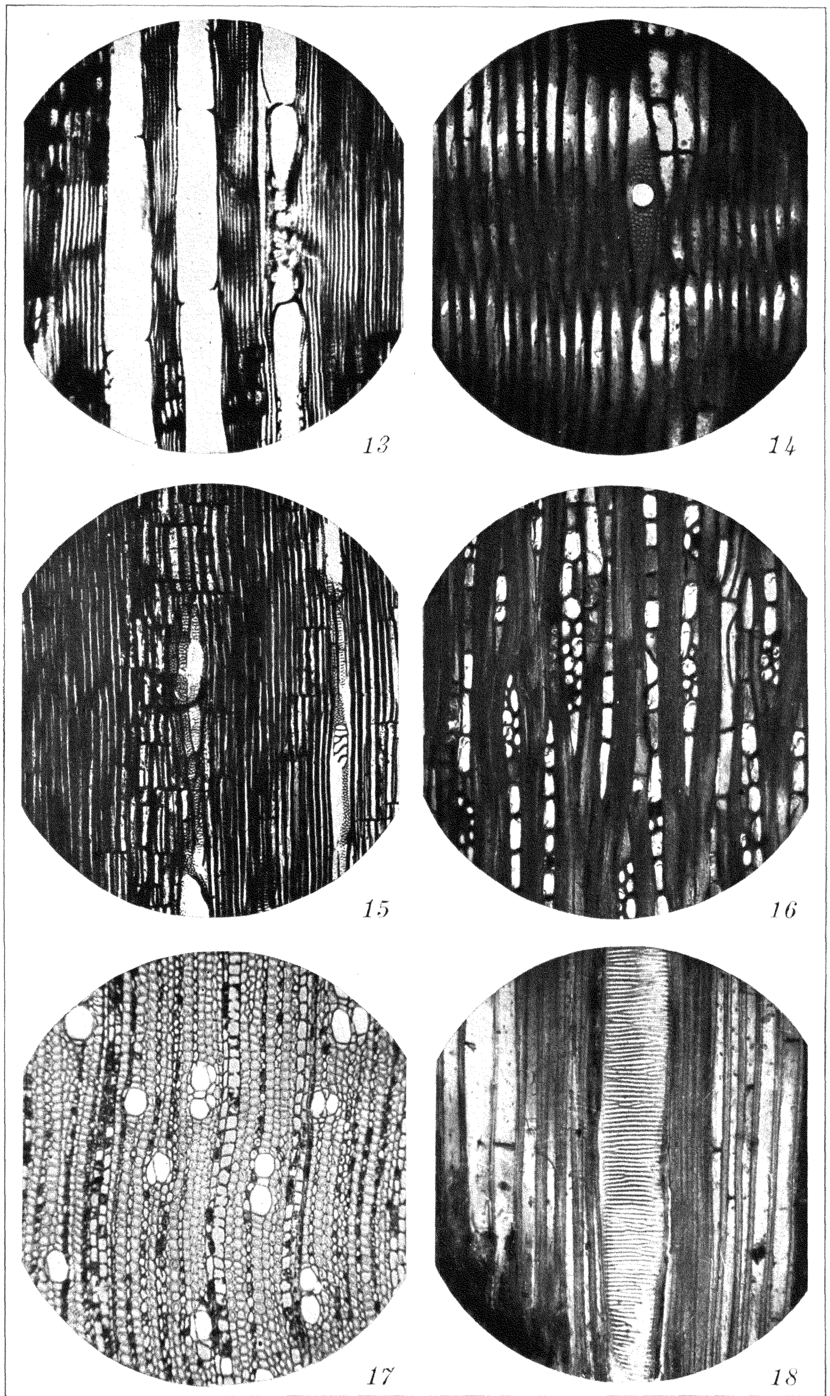

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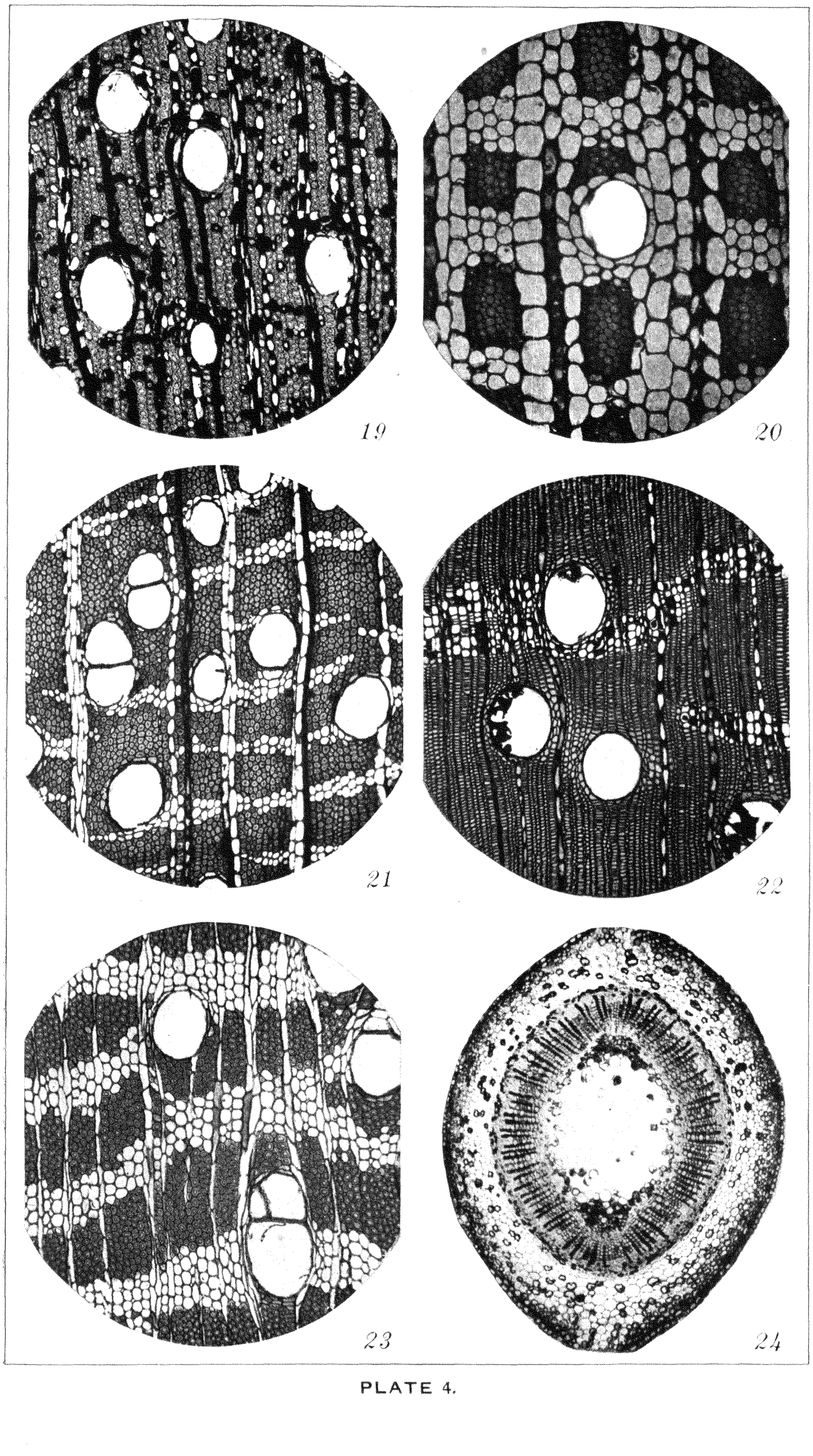

PLATE 4.

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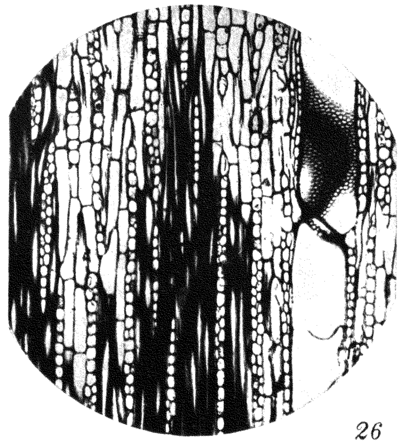

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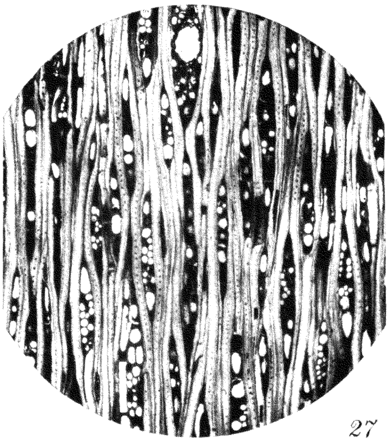

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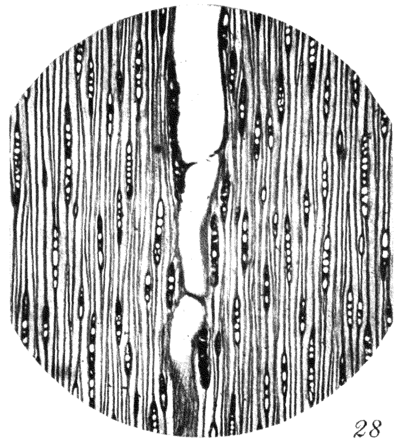

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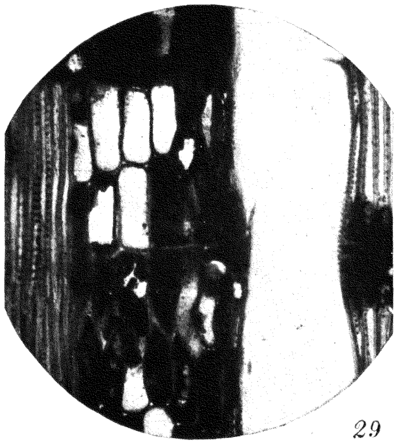

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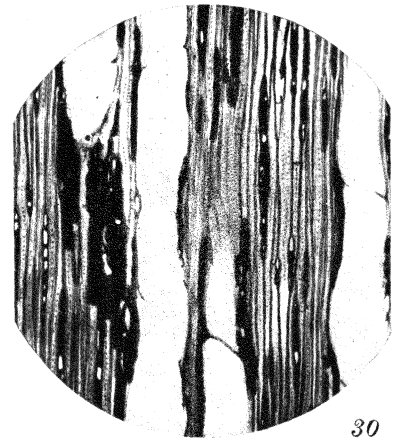

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PLATE 5.

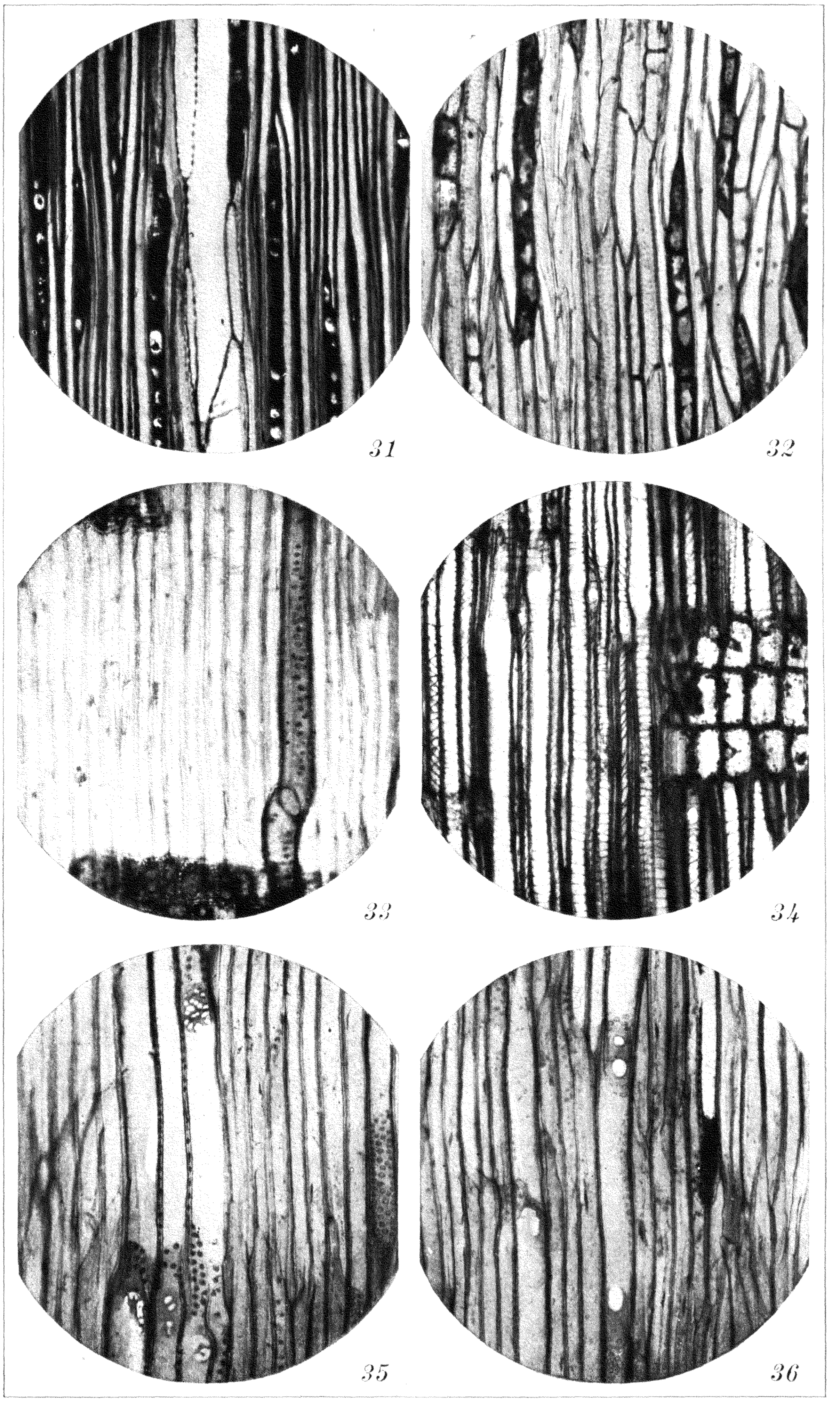


PLATE 6.

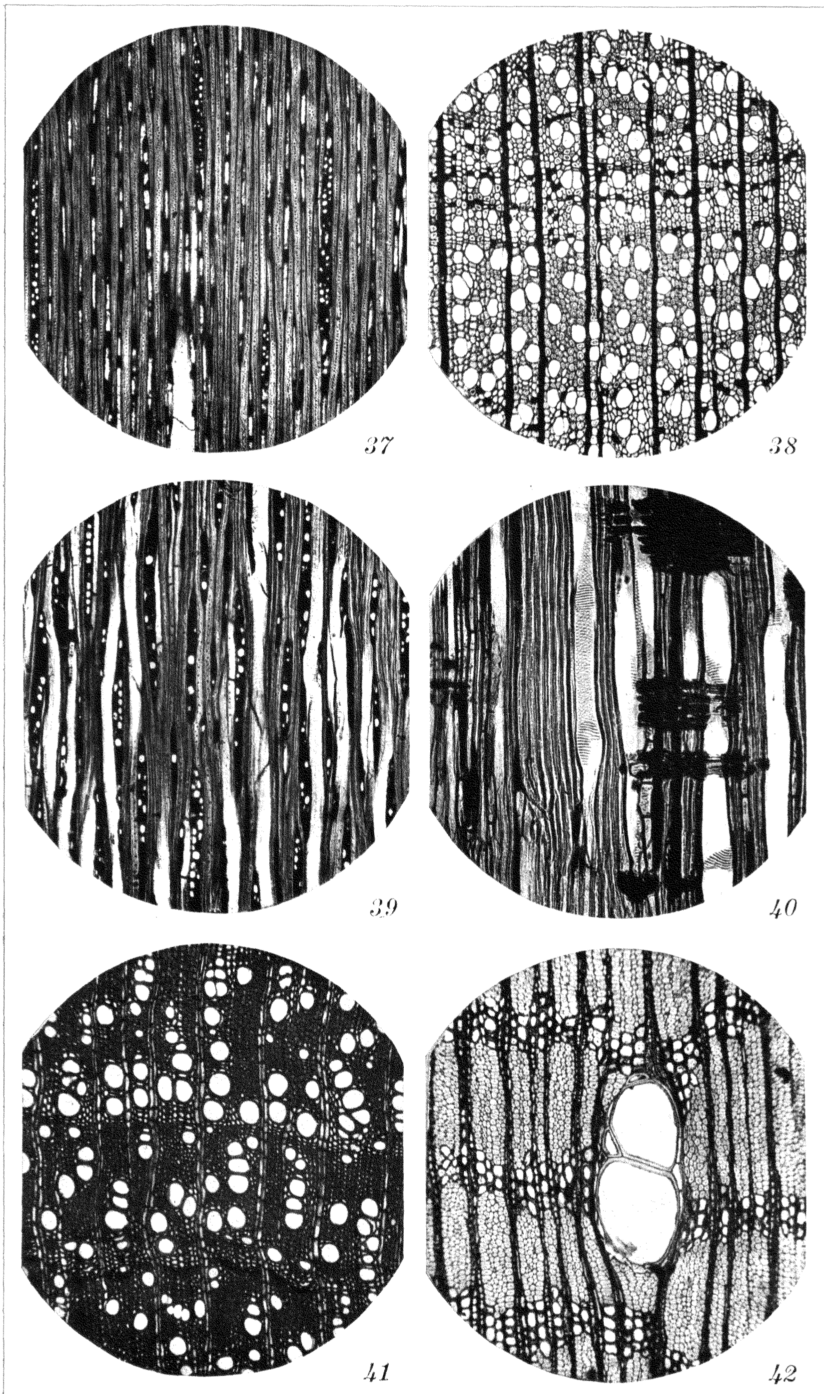


PLATE 7.

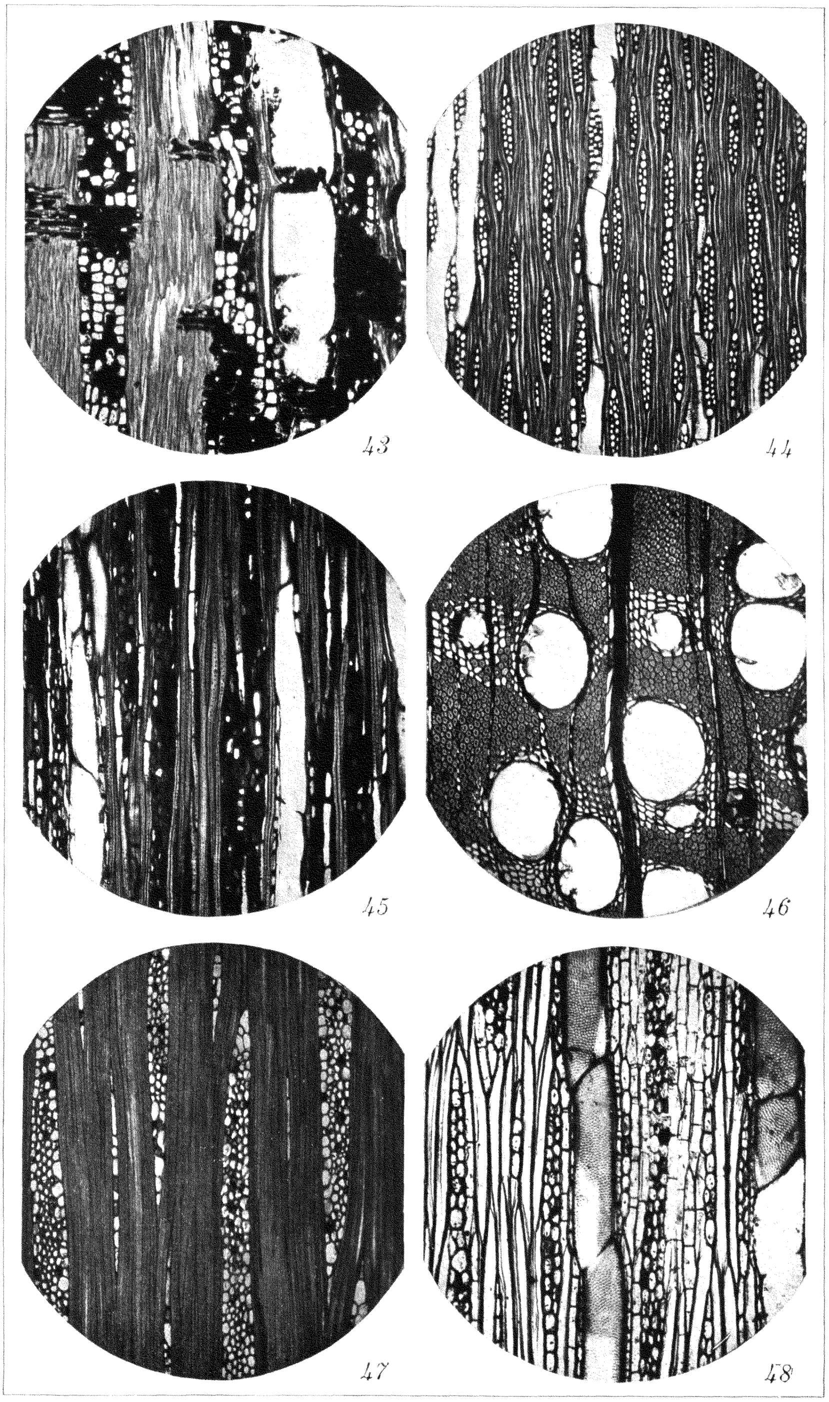
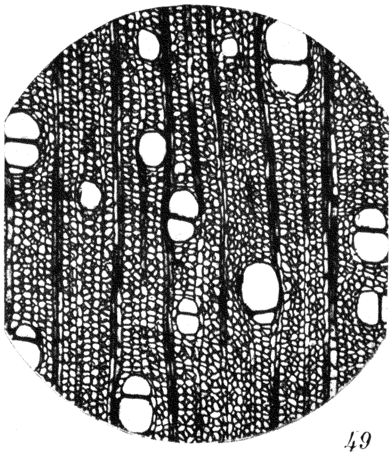


PLATE 8.



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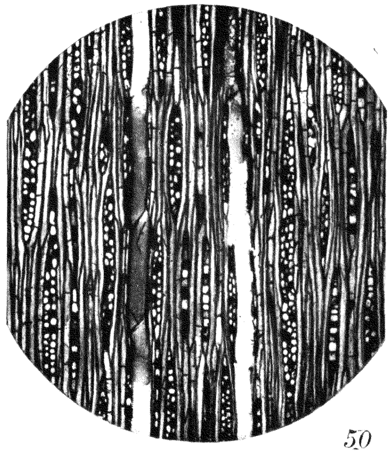

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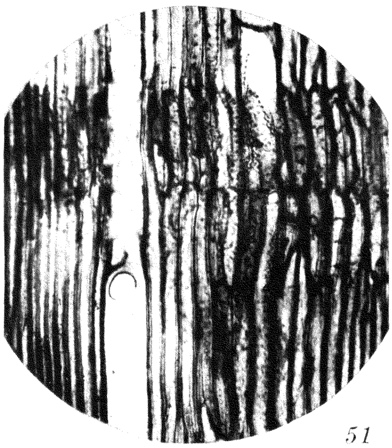

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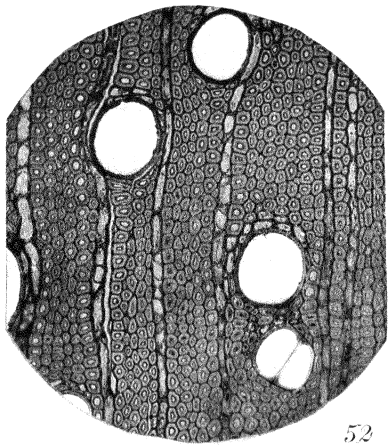

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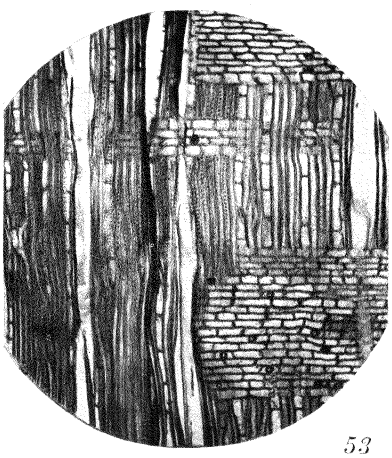

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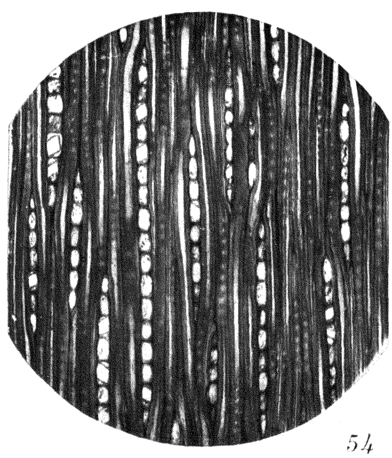

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PLATE 9.

NEMATODES IN THE COLLECTION OF THE PHILIPPINE BUREAU OF SCIENCE, III

By MARCOS A. TUBANGUI and VICTORIA A. MASILUÑGAN

Of the Bureau of Science, Manila

THREE PLATES

Superfamily STRONGYLOIDEA Weinland, 1858

Family TRICHOSTRONGYLIDÆ Leiper, 1912

Genus MOLINEUS Cameron, 1923

MOLINEUS ASIATICUS sp. nov. Plate 1, figs. 4 to 6.

Specific diagnosis.—Molineus: Body small, slender, more or less straight in contour. Cephalic vesicle slightly developed, about 0.05 millimeter long, separated from rest of body by a constriction; a second constriction occurs more posteriorly near level of nerve ring. Cuticle with faint traces of transverse striation in region of cephalic vesicle, elsewhere presenting longitudinal lines. Cephalic and cervical papillæ apparently absent. Œsophagus long, without a distinct bulb. Nerve ring slightly in front of middle of œsophageal length; excretory pore immediately behind that level.

Male: Length 3.6 to 3.8, maximum diameter 0.05 to 0.06 millimeters. Cuticle with 18 equidistant longitudinal lines. Œsophagus 0.24 to 0.27 millimeter long. Bursa well developed, 0.14 by 0.15 millimeter, distinctly divided into two large lateral lobes and a small dorsal lobe, central portions of lateral lobes covered with small spines. Arrangement of bursal rays shown in Plate 1, fig. 6. Ventral rays long, parallel, arising from a common trunk but separated in their distal halves, directed ventro-anteriorly and reaching the edge of the bursa. Lateral rays also with a common trunk, the externolateral slightly thicker but much shorter than the other lateral rays and directed ventrally. Mediolateral and posterolateral rays long and parallel, directed dorsally and reaching bursal edge. Externodorsal rays slightly longer than dorsal ray, but only a little more than one-half as long as the medio- and posterolateral rays. Dorsal ray terminating in two short tridigitate branches,

the middle digit in each branch being the smallest. Spicules 72 to 78 microns long, slightly curved, their proximal ends club-shaped and their distal extremities each terminating in two needlelike processes. Gubernaculum a slender rod, curved ventrally, about 40 microns long.

Female: Length 4.5 to 4.8, maximum diameter 0.05 to 0.06 millimeters. Cuticle with 20 longitudinal striations. Œsophagus 0.28 to 0.31 millimeter long. Posterior end of body rounded, with a ventral knoblike prominence and a terminal spine about 12 microns long. Vulva 0.8 to 1 and anus 0.08 to 0.12 millimeter, respectively, from posterior end. Eggs in uterus thin-shelled, in the one- to two-cell stage, 47 to 49 by 26 to 28 microns.

Host.—*Paradoxurus philippinensis* Jourdan.

Location.—Small intestine.

Locality.—Balanga, Bataan Province, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 530.

Remarks.—The genus *Molineus* also includes *M. felineus* Cameron, 1923; *M. torulosus* (Molin, 1861); and *M. europæus* Zunker, 1929. Compared with these three species, the Philippine representative appears to be most similar to *M. felineus*. Table 1 shows the differences between *M. felineus* and *M. asiaticus*.

TABLE 1.—*Comparison of Molineus felineus and Molineus asiaticus.*

Species.	Size.		Length of spicule.	Length of gubernaculum.
	Male.	Female.		
	mm.	*mm.*	μ	μ
M. felineus	4.75×1	[a] 5.25×1	120	60
M. asiaticus	3.6–3.8×0.05–0.06	4.5–4.8×0.05–0.06	72–78	40

Species.	Bursa.	Externolateral ray.
M. felineus	Not distinctly divided into lobes.	Separated from mediolateral ray only near tip.
M. asiaticus	Distinctly divided into lobes	More completely separated from mediolateral ray.

[a] Cameron's figure "1 mm." for the diameter of *M. felineus* may have been meant for "0.1 m."

Family DIAPHANOCEPHALIDÆ Travassos, 1919

Genus KALICEPHALUS Molin, 1861

KALICEPHALUS sp. Plate 3, figs. 4 and 5.

This nematode is represented in the collection by three female specimens (No. 498) obtained from a cobra. It has been compared with *Kalicephalus minutus* (Baylis and Daubney, 1922), *K. najæ* Maplestone, 1931, and *K. radicus* Bhalerao, 1931, all of which are also parasites of cobras; but in view of the lack of male specimens a specific diagnosis has not been made.

Description.—Kalicephalus: Length 6.5 to 7.0, maximum width 0.35 millimeters, rounded anteriorly and gradually tapering posteriorly into a pointed tail about 0.3 millimeter long. Head compressed laterally, 0.18 millimeter in dorsoventral diameter, 0.13 millimeter in lateral diameter, marked off from rest of body by a very slight constriction. Buccal capsule 0.10 millimeter in maximum dorsoventral diameter, with two valves characteristic of the genus. Each valve with three straight parenchymatous bands, the medial one thicker than the laterals. Duct of œsophageal gland extending more than half the distance into buccal cavity. Œsophagus 0.3 millimeter long, with a distinct posterior bulb. Nerve ring around narrowest part of œsophagus, or immediately in front of middle of its length. Cervical papillæ and excretory pore inconspicuous, opposite middle of œsophageal bulb. Uteri divergent, ovejectors well developed. Vulva prominent, 2.5 millimeters from posterior end. Eggs in utero thin-shelled, segmented, 72 by 42 microns.

Host.—Naja naja philippinensis Taylor.

Location.—Intestine.

Locality.—Alabang, Rizal Province, Luzon.

Superfamily SPIRUROIDEA Railliet and Henry, 1915

Family SPIRURIDÆ Oerley, 1885

Genus METABRONEMA Yorke and Maplestone, 1926

METABRONEMA CARANXI sp. nov. Plate 2, figs. 1 to 6.

Specific diagnosis.—Metabronema: Body elongate, slightly tapering near both extremities. Cuticle transversely striated, the intervals between the striations gradually increasing from 3 to 25 microns in the male and from 4 to 30 microns in the female towards the posterior end of the body. A cuticular band

about 50 microns wide on each side of the body and extending from near the anterior level of the glandular œsophagus to near the posterior end of the worm. Bands more prominent in the male than in the female. Mouth with two rounded lateral lips and surrounded by four submedian papillæ. Pharynx in the form of a narrow tube. Œsophagus divided into an anterior muscular and a posterior glandular portion, the former usually bent or twisted. Nerve ring a short distance behind junction of pharynx and œsophagus.

Male: Length 19, maximum width 0.6 millimeters. Head about 0.15 millimeter in diameter. Pharynx 0.18 to 0.20 millimeter long. Total length of œsophagus 5.8 to 6.7 millimeters, the muscular portion 0.78 to 1.04 and the glandular portion 5.05 to 5.65 millimeters long. Cervical papillæ 0.09 millimeter, nerve ring 0.3 millimeter, and excretory pore 0.7 millimeter, respectively, from anterior end. Posterior extremity spirally coiled, describing one and a half to two complete turns. Cuticle of ventral half of this region of the body as far as caudal alæ thrown into longitudinal folds. Caudal alæ moderately developed. Spicules very dissimilar: right spicule elongate, 1.16 to 1.25 millimeters long by 0.03 millimeter in maximum width at proximal end; left spicule of peculiar shape, 0.34 to 0.40 by 0.05 millimeter. Gubernaculum absent. Nine pairs of genital papillæ, arranged as follows: four pairs of pedunculated papillæ precloacal, four pairs postcloacal, one pair of sessile papillæ subterminal. Cloacal opening about 0.4 millimeter from posterior end.

Female: Length 65 to 70, maximum witdh 1.3 millimeters. Head 0.25 millimeter in diameter. Pharynx 0.23 to 0.29 millimeter long. Total length of œsophagus 10.5 to 12.4 millimeters, the muscular portion 1.18 to 1.27 and the glandular portion 9.35 to 11.10 millimeters long. Cervical papillæ 0.18, nerve ring 0.45, and excretory pore 0.8 millimeter, respectively, from anterior end. Vulva behind junction of anterior and middle thirds of body length, about 25 millimeters from anterior end, and surrounded by a suckerlike prominence. Eggs in utero thick-shelled, embryonated, 42.7 to 45.7 by 24.5 to 26 microns, with polar knobs from each of which two or more filaments arise. Anus 0.3 to 0.4 millimeter from posterior end. Tail bluntly conical.

Host.—*Caranx speciosus* (Forskål).

Location.—Abdominal cavity.

Locality.—San Narciso, Tayabas Province, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 529.

Remarks.—This parasite presents a striking resemblance to *Metabronema magna* (Taylor, 1925), and was at first thought identical with that species, considering that *M. magna*, according to Taylor's description, appears to be a very variable species, and that it has also been reported by Baylis (1934) from a fish in Australia specifically identical with the host of *M. caranxi*. The differences between *M. magna* and *M. caranxi* are shown in Table 2.

TABLE 2.—*Comparison of Metabronema magna and Metabronema caranxi.*

Species.	Ratio of length of anterior portion of œsophagus to length of posterior portion.		Length of right spicule.
	Male.	Female.	
			mm.
M. magna	1:3	1:3	1.70–1.80
M. caranxi	1:6	1:8	1.16–1.25

Species.	Location of vulva.	Eggs.	Gubernaculum.
M. magna	Between 1st and 2d thirds of body length.	37 × 23 μ segmented	Present.
M. caranxi	Behind junction of 1st and 2d thirds of body length.	42.7–45.7 × 24.5–26 μ embryonated.	Absent.

Genus GONGYLONEMA Molin, 1857

GONGYLONEMA sp. Plate 1, fig. 7.

This nematode is represented in the collection by two adult female specimens (No. 509) obtained from a rodent, *Crateromys schadenbergi*. In view of the paucity of material, a specific determination has not been made.

Description.—*Gongylonema:* Length 30 to 50, maximum width 0.18 to 0.24 millimeters. Cuticular plaques extend posteriorly to a level 1.3 to 1.6 millimeters from anterior end of body. Vestibule (pharynx) 0.065 millimeter long. Œsophagus 3.6 to 4.5 millimeters in total length, anterior portion 0.53 to 0.55 and the posterior portion 3.07 to 4.02 millimeters long. Nerve ring 0.25 to 0.27 millimeter from anterior end of body. Vulva 4.4 to 5.9 millimeters and anus 0.13 to 0.17 millimeter, respectively,

from posterior end. Eggs thick-shelled, embryonated, 57.8 to 64.2 by 32 to 34 microns.

Host.—*Crateromys schadenbergi* (Meyer).

Location.—Under mucosa of stomach.

Locality.—Nueva Vizcaya Province, Luzon.

Family RICTULARIIDÆ Railliet, 1916

Genus RICTULARIA Froelich, 1802

RICTULARIA PARADOXURI sp. nov. Plate 3, figs. 1 to 3.

Specific diagnosis.—*Rictularia:* Sexual dimorphism marked, females very much larger than males. Cuticle transversely striated, distance between striations 7.5 to 22 microns in the male and 13 to 28 microns in the female. Mouth directed anterodorsally and surrounded by two ventral and two dorsal papillæ and two lateral amphids. Buccal capsule well developed, with a pair of short conical teeth at its base. Œsophagus divisible into three regions, depending upon the degree of chitinization, the first two short chitinized portions corresponding to anterior muscular portion of œsophagus of other spirurid nematodes. Nerve ring in front of middle of second œsophageal portion. Cervical papillæ in female opposite junction of second and third divisions of œsophagus, in male behind that level.

Male: Length 6.0 to 7.5, maximum width 0.5 to 0.6 millimeters, with 60 to 64 pairs of subventral combs and spines extending from level opposite base of buccal capsule to a level about 0.9 millimeter from cloacal opening. There are also 4 medial combs between last pair of subventral spines and cloacal opening. Œsophagus 2.1 to 2.4 millimeters in total length, anterior portion about 0.14 and second portion 0.28 millimeter long. Nerve ring 0.25 and cervical papillæ 0.5 to 0.6 millimeter, respectively, from anterior extremity. Posterior end of body conical, either bent or slightly coiled ventrally, and apparently without lateral alæ. Ten pairs of sessile genital papillæ, three pairs of these precloacal and seven pairs postcloacal. As shown in Plate 3, fig. 3, the first four pairs of postcloacal papillæ occur in two rows grouped closely together a short distance behind cloacal opening, while the last three pairs are located near the posterior end. Spicules almost equal, right 220 to 260 and left 212 to 255 microns long. Gubernaculum absent.

Female: Length 29 to 32, maximum width 1.05 to 1.12 millimeters, with 92 pairs of subventral combs and spines, of which

46 to 49 are prevulvar and 43 to 46 postvulvar. The postvulvar combs gradually assume the form of spines and reach posteriorly to a level 2.05 to 2.65 millimeters in front of anus. Œsophagus 4.9 millimeters in total length, anterior portion about 0.2 and the middle portion 0.5 millimeter long. Nerve ring 0.42, cervical papillæ 0.84 and vulva 6.5 to 7.0 millimeters, respectively, from anterior end of body. Anus 0.4 to 0.5 millimeter from tip of pointed posterior end. Eggs in utero thick-shelled, in morula stage, 37.8 to 41.5 by 22.6 to 26 microns.

Host.—*Paradoxurus philippinensis* Jourdan.

Location.—Intestine.

Locality.—Balanga, Bataan Province, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 531.

Remarks.—This nematode bears a very close resemblance to *Rictularia houdemeri* Hsu, 1935, a parasite of *Viverra zibetha,* a near relative of the host of the Philippine parasite. The differences between the two species are shown in Table 3.

TABLE 3.—*Comparison of Rictularia houdemeri and Rictularia paradoxuri.*

Species.	Length of female.	Number of combs and spines.		Distance from anterior end to vulva.	Size of eggs.
		Male.	Female.		
	mm.			*mm.*	μ
R. houdemeri	8.35–16.83	65–66	116–118	2.35–3.28	36–39×27–29
R. paradoxuri	29–32	60–64	92	6.50–7.00	37.8–41.5×22.6–26

Superfamily FILARIOIDEA Weinland, 1858

Family FILARIIDÆ (Cobbold, 1864) Claus, 1885

Genus CHANDLERELLA Yorke and Maplestone, 1926

CHANDLERELLA LEPIDOGRAMMI sp. nov. Plate 1, figs. 1 to 3; Plate 3, fig. 6.

Specific diagnosis.—*Chandlerella:* Body elongate, slightly tapering towards both extremities. Cuticle with faint transverse striations. Mouth simple, surrounded by two pairs of submedian papillæ and a pair of amphids. Œsophagus divided into a short anterior muscular portion and a long posterior glandular portion. Nerve ring around junction of middle and posterior thirds of anterior œsophageal region. Excretory pore behind nerve ring, about 0.4 millimeter from anterior end in both sexes, or opposite junction of two œsophageal regions.

Male: Length 30 to 35, maximum width 0.5 to 0.7 millimeters. Posterior end of body spirally coiled, describing one and a half to two complete turns. Œsophagus 2.15 millimeters in total length, anterior portion about 0.25 and posterior portion 1.9 millimeters long. Nerve ring 0.18 to 0.20 millimeter from anterior end. Caudal alæ absent. Spicules almost equal, trough-shaped, 245 to 260 microns long by 45 microns in maximum width, each carrying at its proximal extremity a mass of brownish spongy substance. Genital papillæ few and arranged as follows: one unpaired median precloacal papilla, three pairs of submedian postcloacal papillæ, and one unpaired median terminal papilla (Plate 3, fig. 6). Cloacal opening about 0.16 millimeter from posterior end.

Female: Length 50 to 55, maximum width 0.9 millimeters. Posterior end of body broadly rounded, with a small unpaired subterminal papilla. Œsophagus 2.7 millimeters in total length, anterior muscular portion 0.38 millimeter long. Nerve ring about 0.25 millimeter from anterior end. Vulva opposite junction of anterior and middle thirds of length of glandular œsophagus or 1 to 1.2 millimeters from anterior end of body. Vagina about 3 millimeters long. Eggs in utero thin-shelled, embryonated, 94.5 to 100.5 by 51 to 53 microns. Anus 0.15 millimeter from posterior end.

Host.—*Lepidogrammus cumingi* (Fraser).

Location.—Cœlome.

Locality.—Virac, Albay Province, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 520.

Remarks.—The genus *Chandlerella* was proposed by Yorke and Maplestone (1926) for a bird parasite which was described by Chandler (1924) under the name *Filaria bosei.* Recently Li (1933) placed in the same genus another bird nematode, *C. sinensis,* which, like the Philippine species, differs from the genotype in the structure of the œsophagus and in the arrangement of the uteri. *Chandlerella lepidogrammi* may be distinguished from *C. sinensis,* as shown in Table 4, by its larger size, the position of the vulva, the length of the œsophagus in proportion to body length, and the length of the spicules.

TABLE 4.—*Comparison of Chandlerella sinensis and Chandlerella lepidogrammi.*

Species.	Size.		Distance from anterior end to vulva.
	Male.	Female.	
	mm.	*mm.*	*mm.*
C. sinensis	15–18×0.14–0.17	23–25×0.23–0.25	0.36–0.43
C. lepidogrammi	30–35×0.50–0.70	50–55×0.90	1–1.20

Species.	Ratio of length of œsophagus to body length.		Length of spicules.
	Male.	Female.	
			μ
C. sinensis	1:25	1:33	Unequal; right 70–80, left, 50–60.
C. lepidogrammi	1:15	1:19	Almost equal, 245–260.

LITERATURE CITED

BAYLIS, H. A. Three helminthological notes. I. The nematode genera Cystidicola, Metabronema, and Cystidicoloides. Ann. & Mag. Nat. Hist. X **14** (1934) 115–118.

BHALERAO, G. D. Two new parasites from the king cobra (Naja hannah). Ann. & Mag. Nat. Hist. X **8** (1931) 102–109.

CAMERON, T. W. M. Studies on two new genera and some little known species of the nematode family Trichostrongylidae Leiper. Journ. Helminth. **1** (1923) 71–96.

CHANDLER, A. C. New Filariae from Indian birds. Parasit. **16** (1924) 398–404.

HSU, H. F. A study of some Strongyloidea and Spiruroidea from French Indo-China and of Thelazia chungkingensis Hsu, 1933 from China. Zeitschr. f. Parasit. **7** (1935) 579–600.

LI, HSI-CHIEH. Report on a collection of parasitic nematodes, mainly from North China. I. Filarioidea. Parasit. **25** (1933) 192–223.

MAPLESTONE, P. A. Parasitic nematodes obtained from animals dying in the Calcutta Zoölogical Gardens, pts. 4–8. Rec. Indian Mus. **33** (1931) 71–171.

ORTLEPP, R. J. Observations on the nematode genera Kalicephalus, Diaphanocephalus, and Occipitodontus g. n., and on the larval development of Kalicephalus philodriodus sp. n. Journ. Helminth. **1** (1923) 165–189.

TAYLOR, E. L. Notes on some nematodes in the Museum of the Liverpool School of Tropical Medicine. II. Parasit. **19** (1925) 57–69.

YORKE, W., and P. A. MAPLESTONE. The Nematode Parasites of Vertebrates. P. Blakiston's Sons & Co., Philadelphia (1926) xi + 536 pp.

ZUNKER, M. Molineus europaeus spec. nov., ein neuer Nematode aus dem Darm des Iltis (Putorius putorius). Zeitschr. f. Parasit. **2** (1929) 7–11.

ILLUSTRATIONS

[Drawn by B. Escuadro.]

PLATE 1

FIG. 1. *Chandlerella lepidogrammi* sp. nov., anterior end of female, lateral view.
2. *Chandlerella lepidogrammi* sp. nov., posterior end of female, lateral view.
3. *Chandlerella lepidogrammi* sp. nov., posterior end of male, lateral view.
4. *Molineus asiaticus* sp. nov., anterior end of male, lateral view.
5. *Molineus asiaticus* sp. nov., posterior end of female, lateral view.
6. *Molineus asiaticus* sp. nov., posterior end of male, dorsal view.
7. *Gongylonema* sp., anterior end of female, lateral view.

PLATE 2. METABRONEMA CARANXI SP. NOV.

FIG. 1. Anterior end of female, lateral view.
2. Anterior end of female, ventral view.
3. Mouth and papillæ, anterior view.
4. Posterior end of female, lateral view.
5. Posterior end of male, lateral view.
6. Egg showing polar filaments and inclosed embryo.

PLATE 3

FIG. 1. *Rictularia paradoxuri* sp. nov., anterior end of female, lateral view.
2. *Rictularia paradoxuri* sp. nov., anterior end of female, dorsal view.
3. *Rictularia paradoxuri* sp. nov., posterior end of male, lateral view.
4. *Kalicephalus* sp., anterior end of female, lateral view.
5. *Kalicephalus* sp., posterior end of female, lateral view.
6. *Chandlerella lepidogrammi* sp. nov., posterior end of male, ventral view.

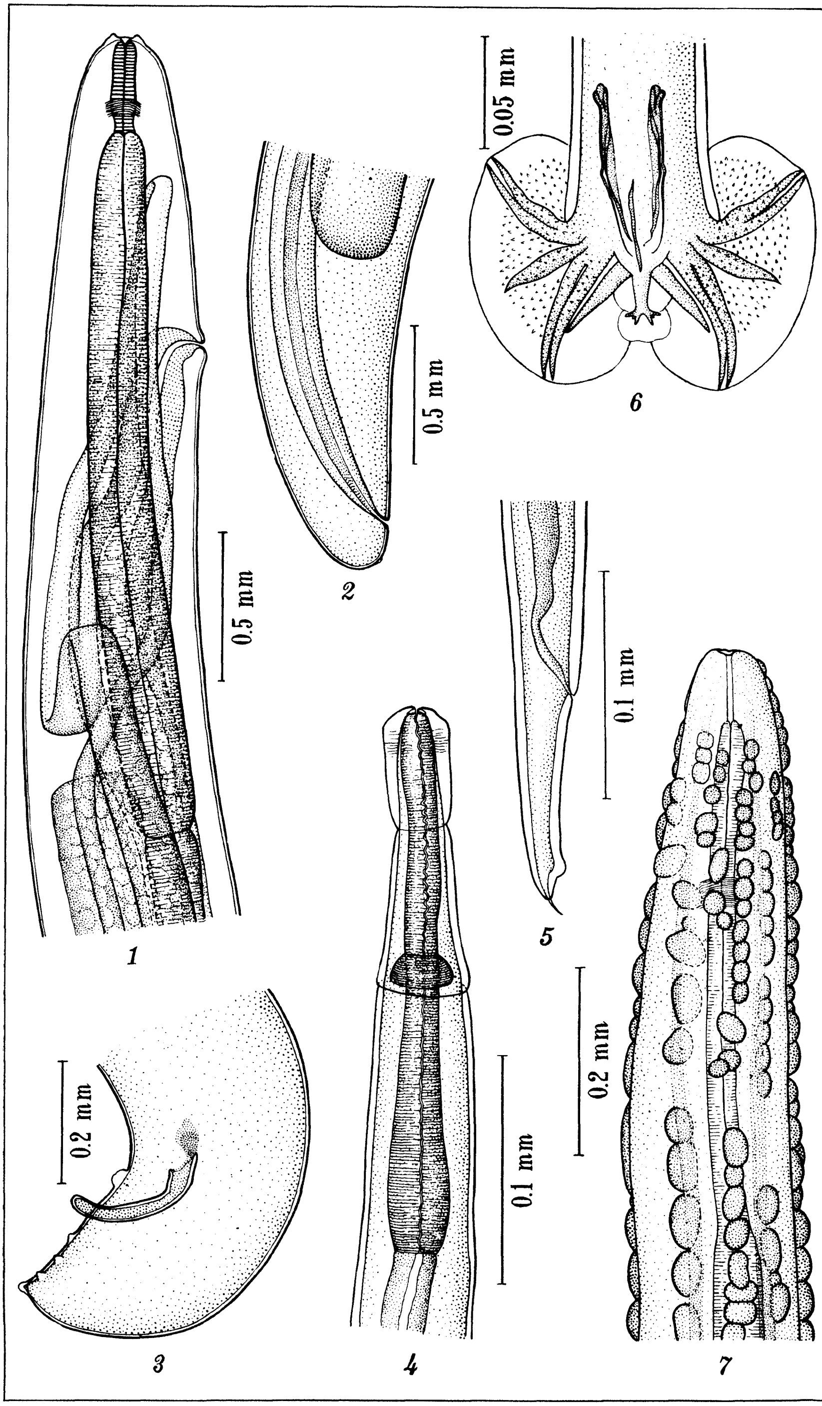

PLATE 1.

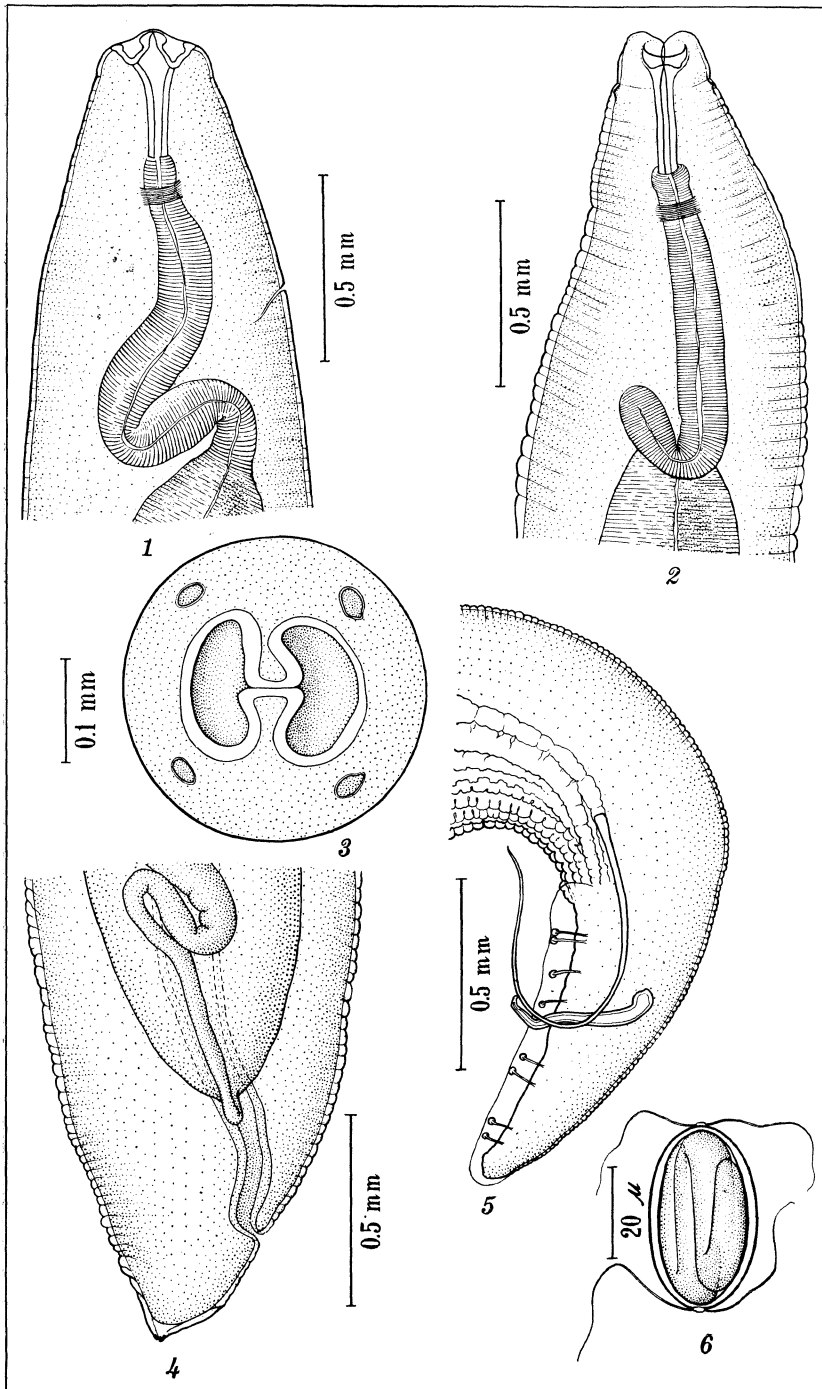

PLATE 2.

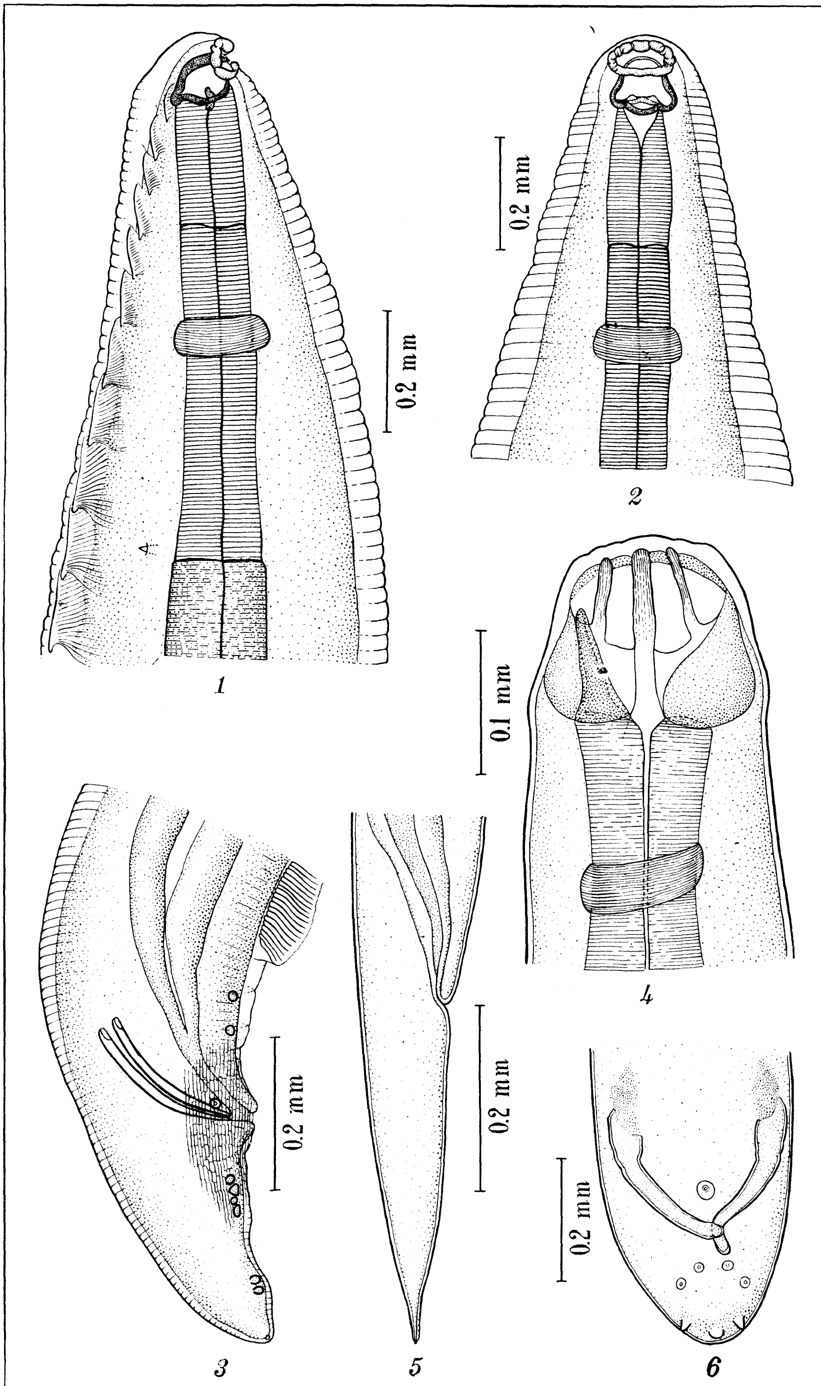

PLATE 3.

SI-SI FISHERY OF SAMAR, PHILIPPINE ISLANDS

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ONE PLATE AND ONE TEXT FIGURE

A great variety of marine, brackish, fresh-water, and land mollusks are known to inhabit Philippine waters. Many of them are utilized commercially, the shells for ornamental purposes and the soft parts as food. Philippine oysters are widely distributed along our shores, and their meat is in great demand, either fresh or preserved. In many places the natural supply is artificially augmented by cultivation. In the western central part of Samar, particularly along the rocky coastline of the islands within the jurisdiction of the municipalities of Catbalogan and Zumarraga, Samar Province, species of small oysters, generally known as *si-si,* are found in great abundance. Although the si-si are not cultured, the supply being furnished by nature, the fishery is an important source of livelihood for several hundred families inhabiting the province. Sampans from Leyte, Bohol, Cebu, and Masbate also sail to these places to buy si-si, either fresh or preserved. Some of the products are taken to interisland vessels which make regular calls at either Catbalogan or Zumarraga ports, and sold to the passengers. Owners of salting houses, too, send si-si to either the northern part of Luzon or to Hawaii.

Here presented are the descriptions of the several species of si-si, their habitats, the extent of the si-si fishery, methods of collection and of preservation found in towns of Catbalogan and Zumarraga, Calbayog, Santa Margarita, Gandara, and Villareal, and the islands within their jurisdiction, all in the western central part of Samar.

DESCRIPTION OF THE SPECIES

There are three known species of si-si; *si-si* proper, *Ostrea cucullata* Born; *si-si wak, Ostrea malabonensis* Faustino; and *pol-pol, Ostrea palmipes* Sowerby.[1] The last is the largest of

[1] The local name *pol-pol* may be given to any immature oyster found attached to small stones; the si-si wak is an immature oyster of larger size, attached to big boulders found far from mouths of fresh-water streams.

the three species, and is easily recognized by the shape of the shell, which is more or less rectangular with rounded corners. It is mostly found attached to stones and small rocks on protected places, and sometimes near the mouth of streams. The other two, although usually smaller, are preferred because of their delicate flavor. *Ostrea malabonensis* Faustino attaches itself singly on rocks that are more or less exposed. It usually grows larger than *O. cucullata* Born. The latter grows in mats, covering large boulders of rocks, also on exposed places.

Ostrea malabonensis Faustino.—This species is only 20 to 44 millimeters long. The shells are generally attached singly to other shells. They are oftentimes roughly triangular or irregularly oblong and solid-looking. The lower valve is deeply concave with numerous large and somewhat rounded plaitings. The upper valve is more or less flat, although at times it is also plaited at the margin. The edges of the valve next the hinge are toothed, and the interior of the shell has greenish spots.

The spawning season of this oyster begins in November and ends in March, when the oyster is fat. During this period the oysters are gathered in large numbers.

Ostrea palmipes Sowerby.—This species reaches a length of from 25 to 60 millimeters. The shell is thin, much compressed, more or less rectangular in outline, with rounded corners. The shells are generally flat, but when attached to rounded surfaces of stones and small rocks, they become more or less concave. The lower valve, which is prominently ribbed and tuberculated, extends beyond the upper valve. The latter is smaller, smooth, and only obscurely rayed.

Ostrea cucullata Born (Plate 1, figs. 1 and 2).—This si-si is the most abundant of the three species. Like in *O. malabonensis,* the shells grow singly but in mats covering the surfaces of big boulders of rocks found in places exposed to waves and far from the mouths of streams. The spawning season is from May to November of each year, when this oyster is also in season.

The shell is generally subtrigonal, solid, rather plaited, whitish toward the apex and purple toward the margin. The lower valve extends deeply beyond the flat opercular upper valve. The interior is yellowish brown with a slight purple tinge. The upper valve is brownish near the base, and purple toward the margin which is denticulated to about two-thirds from the hinge line.

The specimens on hand are apparently immature and show the effects of crowding. They range from 10 to 20 millimeters in diameter and do not show the characteristics of the species fully. This species is very closely allied to *O. malabonensis* and *O. plicata*. The lower valve of *O. cucullata* is slightly cup-shaped, with the upper valve opercular, while that of *O. malabonensis* is horsehoof-shaped. The valves of *O. plicata* are more or less uniform and strongly plaited.

DISTRIBUTION AND HABITAT

Ostrea cucullata and *O. malabonensis* are confined to between tide marks along the rocky and exposed coasts of the municipalities of Catbalogan, Zumarraga, Santa Margarita, and Villareal, and the islands belonging to them. They cover big rocks like a mat or are found on solid rocky bottoms which are completely exposed during low tide. They are not encountered near the mouths of fresh-water streams, probably because they require a higher degree of salinity of water than *Ostrea palmipes*. Natural beds of these two oysters are found in the following localities:

Santa Margarita Municipality: Libucan Islands; Catbalogan Municipality: Canahauan Islands, northern coasts of the islands of Canahauan Daco, Canahauan Guti, Batgongon, Boloang, Balading, Ani, Cambalai, Sampotan, Cagdullon, Buri, Darajuay and Majaba, the reefs Bolo, Lutao, and Waray Bancoa; as well as along the coasts of Samar between Anas and Jesus points; Zumarraga Municipality: Buad Islands—San Isidro, Tinaogan, Bioso, Tubigan, Ga-ang, Mualbual, Bublaran, and Macalunos; Dram Islands—Bagacay and Baclayon; Parasan Islands—Rizal, Parasan, and all islands and reefs along Zumarraga and Buad channels; Villareal Municipality: Talalora.

Ostrea palmipes is found only in sheltered places and near the mouths of fresh-water streams in the following places:

Calbayog Municipality: Trinidad (Sabang); Santa Margarita Municipality: Sondara Islands; Gandara Municipality: Napalisan Islands and the islands of Caparangasan and Bangon; Taranganan Municipality: Cambatutay Bay; Catbalogan Municipality: along Maulong Bay; Zumarraga Municipality: Baclayon, Bagacay, and Bontay Islands, and Burabud Bay.

METHOD OF COLLECTION

Si-si are gathered usually during low tide, when the beds are well exposed. Because the shells are attached to big boulders

and rocks, they are shucked right at the spot. An implement used for gathering is called *tete* (text fig. 1, *a*). This is a curved and chisellike pointed iron fitted with either a round wooden or a bamboo handle about 40 centimeters long. The si-si is tipped with the *tete* until the upper valve is removed, leaving the meat and lower valve on the rock. The meat is then extracted with an awl (text fig. 1, *b*) or any pointed wire, iron, or bamboo, and placed in a can or earthen jar.

Due to the small size of the oyster, one can gather only one ganta [2] at most during one low tide. Consequently few oysters are sold fresh on the markets. It takes several days to fill orders of one petroleum or gasoline can of salted si-si meat.

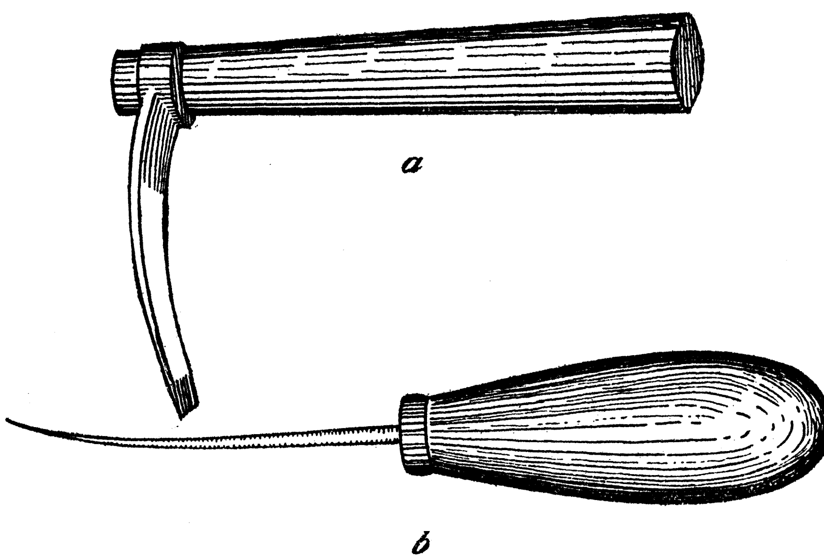

FIG. 1. *a*, Tete; *b*, awl.

It takes more time when the lowest tides occur during the night. The intervention of middlemen also has a deterring effect on the fishery. After receiving orders at a certain price a middleman goes to the gatherers and buys at a gain whatever salted si-si these have until he has bought enough to cover his orders. Sometimes he hires several gatherers, feeds them, then buys whatever amount they collect at a very low price.

UTILIZATION

Si-si are sold either fresh or preserved in the local markets. The fresh meat is usually eaten raw, with or without vinegar.

[2] 3.99 liters.

Sometimes it is pickled with vinegar seasoned with onion, salt, and pepper. Well-seasoned si-si is also made into omelet. This preparation is often served in local restaurants in the form of si-si sandwiches.

Great quantities of si-si are preserved into a form of salted product locally known as *guinamos.* After the meat is removed from the shells, it is washed well in fresh or salt water. Then it is placed in earthen jars or any receptacle and salted in the proportion of three parts si-si to one part Manila salt by volume. After this mixture is allowed to ferment for one week, it is packed in petroleum or gasoline cans and sealed. Sometimes it is placed in small bottles and sold at 10 to 15 centavos a bottle. Salted si-si from the neighboring islands are brought to the interisland vessels that make regular calls at Catbalogan port.

The Lorenzana bagoong factory buys salted si-si in great quantities and sends them to its central plant in Manila, where they are packed in 1-pound salmon cans and sealed. The process used is apparently not satisfactory, as the canned product often swells due to gas formation resulting from fermentation of the contents, and thus becomes unfit for food.

The usual proportion of three parts si-si meat to one part Manila salt is apparently not satisfactory, especially when the receptacle is not properly sealed. Molds grow on the top layer after the second week, and the contents give off a foul odor after seven weeks.

An experiment was undertaken at the Fish Preservation Station of the Bureau of Science at Catbalogan, Samar, to determine the best proportion of si-si meat to salt in the making of guinamos. The following procedure was used:

About 6 liters of si-si meat was washed in fresh water three times, after which the lot was divided into six parts, numbered 1 to 6. Each part was salted as follows:

1—One part si-si meat to one part Manila salt.
2—Two parts si-si meat to one part Manila salt.
3—Three parts si-si meat to one and one-half parts Manila salt.
4—Three parts si-si meat to one part Manila salt.
5—Four parts si-si meat to one part Manila salt.
6—Five parts si-si meat to one part Manila salt.

Each part was placed in a separate glass jar, properly covered, and labeled as bottles 1, 2, 3, 4, 5, and 6, respectively. Table 1 shows the result of the experiment.

TABLE 1.—*Result of experiment in salting si-si, undertaken at the Bureau of Science Fish Preservation Station, Catbalogan, Samar.*

Bottle.			After 1 week.		After 2 weeks.		After 3 weeks.		After 4 weeks.	
No.	Parts si-si.	Parts salt.	Taste.	Smell.	Taste.	Smell.	Taste.	Smell.	Taste.	Smell.
1	1	1		Good	Too salty	Good	Too salty		Too salty	
2	2	1		do	do	do	Quite salty		Quite salty	
3	3	1.5	Too salty	do	Good	do	Good		Good	
4	3	1	Good	do	do	do	do		Fair	
5	4	1		do						Very foul.
6	5	1		do		Foul		Very foul		

Bottle.			After 5 weeks.		After 6 weeks.		After 7 weeks.		After 8 weeks.	
No.	Parts si-si.	Parts salt.	Taste.	Smell.	Taste.	Smell.	Taste.	Smell.	Taste.	Smell.
1	1	1	Too salty		Too salty		Too salty		Too salty	
2	2	1	Quite salty		Good		Good		Good	
3	3	1.5	Good		do		do		do	
4	3	1	Fair			Foul				Foul.
5	4	1								
6	5	1								

Bottle.			After 3 months.		After 4 months.		After 5 months.		Remarks.
No.	Parts si-si.	Parts salt.	Taste.	Smell.	Taste.	Smell.	Taste.	Smell.	
1	1	1	Too salty		Too salty		Too salty		
2	2	1	Good		Good		Good		
3	3	1.5	do		do		do		Mold on top layer after 3 months.
4	3	1							Mold on top layer after 2 weeks. Sauce reddish after 6 weeks. Si-si thrown away after 8 weeks.
5	4	1							Mold on top layer after 1 week. Sauce brick red after 2 weeks, dull red after 3 weeks. Si-si thrown away after 4 weeks.
6	5	1							Mold on top layer after 1 week. Sauce dull brick red after 2 weeks. Si-si thrown away after 3 weeks.

As can be seen from Table 1, the contents of bottles 1, 2, and 3 kept well up to the 5th month. The contents of bottle 1, however, were altogether too salty to the taste; the contents of bottle 2 were apparently sufficiently salted to prevent the growth of molds; while the contents of bottle 3, although of good flavor, developed a large amount of mold at the upper layer. The contents of bottle 4 developed molds after the first week, turned reddish at the 6th week, and emitted a foul odor after the 7th week. The contents of bottle 5 developed mold from the very first week and was thrown away after four weeks due to the foul odor; the contents of bottle 6 were thrown away after the third week for the same reason.

STATUS OF THE FISHERY

The municipalities where si-si beds are located have no regulations and exercise no control over the si-si fishery, probably because of the presence of other more important fisheries yielding larger revenues. Everyone, therefore, can gather si-si without securing a license or permit. Taking advantages of the situation, owners of salting factories, who are almost all Chinese, control the industry. The fishermen, with very few exceptions, are contracted to deliver the cleaned meat to these salters who advance money to be paid in si-si meat at a price agreed upon when the money was obtained. These salters always have the upper hand in the transaction, as the native fishermen have to dispose of their product in large quantities at prices dictated by salter.

Quite recently, however, as the demand for and the exportation of bagoong and other preserved fish products increased, Catbalogan and Zumarraga passed ordinances imposing a fee of 2 centavos for every can or box of either salted or dried fish exported. Native fishermen and gatherers have also begun to sell their raw products direct to the firms through agents sent by the latter to the fishing centers. Hence their products now command better prices.

No adequate data could be obtained on the exact value of the industry. However, it has been estimated by both municipal and provincial officials that not less than 700,000 kilos of si-si meat, worth 75,000 pesos, is gathered annually. With the apparently increasing demand from year to year, it may be expected that the value of the fishery may have also increased. At present a 5-gallon can of salted si-si is sold at a price ranging from 2.50

to 4.50 pesos, the price being highest from January to March, when the supply is low.

CONCLUSIONS AND RECOMMENDATIONS

1. The most important si-si beds are found at Catbalogan and Zumarraga and the small islands belonging to these municipalities.

2. There are three species of si-si known; namely, *Ostrea cucullata* Born, *Ostrea malabonensis* Faustino, and *Ostrea palmipes* Sowerby. The first is the most abundant, and, together with *O. malabonensis* Faustino, grows in mats over big rocks and plain rocky bottoms which are completely exposed during low tide and far from fresh-water streams. *Ostrea palmipes* grow on smaller rocks or stones in sheltered places and near the mouths of fresh-water streams.

3. Unlike other places where oysters are found, the si-si in western Samar are not cultivated in farms, and apparently no effort is being made to augment the natural supply.

4. In view of the apparently increasing demand for si-si, and the lack of a scientific method of their cultivation, it is feared that the natural supply is seriously threatened. Over-fishing is noted everywhere, especially at Waray Bancoa reefs, Darajuay Island, and Bioso, where excellent natural beds of this oyster are located. The specimens brought to the Bureau of Science are 10 to 15 millimeters long; these are usually harvested while they are still immature. *Ostrea cucullata* reaches a size of 40 to 60 millimeters.

5. Recent investigations made by the Fish and Game Administration of the Bureau of Science reveal that *O. malabonensis* Faustino and *O. palmipes* can be cultured artificially to grow larger at a rapid rate, by the use of wires and empty oyster shells. Roughley (1922) also claims that *O. cucullata* Born is being cultured with the use of stones, wood, or wire trays at George's River, New South Wales. These known methods should be studied and adapted to the conditions of the local beds. Once the best method of culture is known and applied, the supply is not only stabilized but a better quality of bigger and fatter shellfish is insured. The product can be brought fresh to distant markets, as experiments show that *Ostrea cucullata* can live two weeks out of water (Roughley, 1922); *O. malabonensis* Faustino, five days; and *O. palmipes* Sowerby, about three days (Talavera and Faustino, 1933).

6. Cleanliness in the preparation of salted si-si and during the process of fermentation is not observed. Receptacles used are not properly cleaned and salted si-si are not properly sealed and thus are easily accessible to flies and other insects.

7. The proportion of si-si meat to Manila salt must not be less than 2:1 if the product is to be kept for a period longer than 15 days.

REFERENCES

1. FAUSTINO, L. A. Recent and fossil shells from the Philippine Islands, I. Philip. Journ. Sci. **49** (1932) 543.
2. REEVE, L. A. Conchologia Iconica (1873) pl. 16, fig. 34.
3. ROUGHLEY, T. C. Oyster culture on George's River, New South Wales (1922).
4. TALAVERA, F., and L. A. FAUSTINO. Edible mollusks of Manila Bay. Philip. Journ. Sci. **50** (1933) 1–48.

ILLUSTRATIONS

PLATE 1

FIG. 1. Dorsal and ventral view of the upper valve of *Ostrea cucullata* Born.
2. A group of *Ostrea cucullata* Born, taken from a rock.

TEXT FIGURE

FIG. 1. *a*, Tete; *b*, awl.

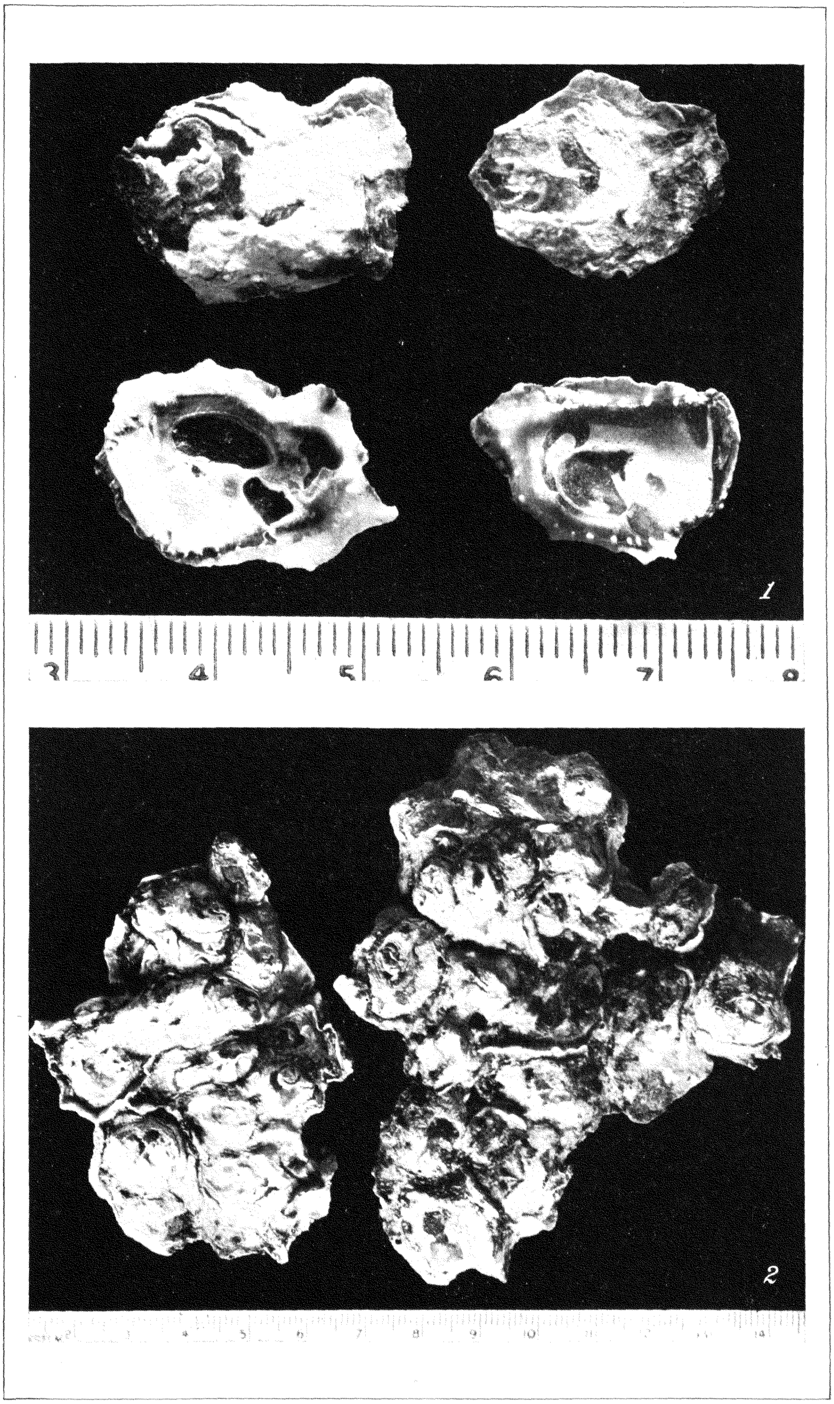

PLATE 1.

AN UNUSUAL BUD DUE TO HETEROMORPHOSIS IN ECHINASTER LUZONICUS (GRAY)[1]

By JOSÉ S. DOMANTAY

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ONE PLATE

Budding is occasionally reported among the higher groups of animals, such as the flatworms, the annelids, and even the lower chordates. Among other animals budding is almost unknown. Regeneration is, however, very common among all animals. It usually takes place after fission or after autotomy. Autotomy is common among the higher animals, as some echinoderms, annelids, and arthropods, although it is apparently unknown among the highest group of animals. Regeneration following fission or autotomy among lower animals is very remarkable in restoring entirely the lost part of the organism. Among the vertebrates, however, where autotomy is apparently unknown, regeneration is confined to the healing of the cut part or wound.

Among the Echinodermata autotomy is known in ophiuroids, holothurians, and crinoids. In the ophiuroids and crinoids it is manifested in the breaking or snapping off of arms when the animal is caught, in order to escape from an enemy. Among holothurians preyed upon or disturbed by an enemy, however, it is manifested in the throwing off of the internal organs. All the lost parts of the body are restored after some time by reconstitution. Among the asteroids and echinoids autotomy is apparently not known, although regeneration or reconstitution is the prevailing phenomenon. It has been reported that when a single starfish is cut into many small pieces and thrown back into the sea, each piece regenerates into a complete animal. This is a case of reconstitution in the stricter sense of the word.

This report is corroborated by my findings in Puerto Galera Marine Biological Station in *Echinaster luzonicus* (Gray), the single arm or portion of an arm of which often regenerates into a complete animal.

[1] Read before the Fourth Philippine Science Convention, Manila, February 24, 1937.

The bud is found on the abactinal side of the body (Plate 1, fig. 3). In my specimen the bud occurred between the base of one arm of the trivium and the centrodorsal disc. It has four rays, while the mother starfish has six. This abnormal budding may be explained physiologically as reconstitution, or heteromorphosis. According to findings in *Euplanaria* (*Planaria*) by Child, Sivickis, and others, the capability for regeneration along the main axis of the body corresponds to the axial metabolic gradients in the body of the individual. It is, therefore, presumed that in the body of any organism the metabolic rate is higher in the head region where the nerve center or brain is located. In a radiate organism, like the starfish, where there is no cephalization, there is no corresponding centralization of sense organs, hence the metabolic rate is almost the same all over except possibly along the nerve pentagon (nerve ring) of the epidermal and the deep nervous system, which are found within the body and along the radii of the arms. This accounts for the complete regeneration of any injured part in the neighborhood of the nerve ring and the radial nerves. In this same species, when a single arm is cut off from the body, the cut end, which is the proximal end, usually regenerates into a complete animal, forming a comet-shaped individual (Plate 1, figs. 4 to 6). Also, the ray from where the cut arm has been removed regenerates into a fully developed arm. A *Linckia multifora* with one intact arm producing a comet-shaped ray by budding has been reported by Richard Hertwig in 1924, which indicates the absence of a distinct highly metabolic region in the starfish. The entire disc or body, together with the radii of the starfish, may correspond to the cephalic region of those axial animals with distinct head, hence there is slight differentiation in this region, so that when the animal is injured at any point along these regions the tendency of the injured part is to regenerate into a complete miniature individual, forming a bud. The question may be asked, why in *Echinaster luzonicus* is there not a single case of an entire individual with a cut arm regenerating into a complete or comet-shaped ray as has been reported of *Linckia multifora?* This phenomenon may be a species specific in nature. In *E. luzonicus* the comet form is always produced at the proximal part of the ray and not at the distal end, as in *Linckia multifora*.

From the embryological and physiological point of view this unusual budding may be explained by the conjoining of auto-

site and parasite twins, the mother starfish being the autosite and the bud the parasite. The lateral budding theory of the origin of conjoined twins may also explain this unusual bud. The bud may be compared to a condition found in certain plants with a terminal growing point. When the normal rate of growth at the growing point is not disturbed, the secondary buds are inhibited; but when the primary bud is injured, the secondary buds arise and grow, although they are often partially inhibited by the presence of the primary bud, and are therefore very much smaller than the latter.

ACKNOWLEDGMENT

The writer is indebted to Dr. Felix V. Santos, of the Department of Zoölogy, University of the Philippines, for constructive suggestions, and to Dr. Leopoldo S. Clemente, acting head of the same Department, for going over this paper.

REFERENCES

CHILD, C. M. Physiological Foundation of Behavior. Henry Holt and Co. (1924).

CHILD, C. M. Senescence and Rejuvenescence. University of Chicago Press (1915).

DOMANTAY, J. S. Autotomy in holothurians. Univ. Philippines Nat. and Appl. Sci. Bull. 1 (1931) 389–404.

KINGSLEY, J. S. Hertwig's Manual of Zoölogy, Henry Holt and Co. (1924).

LOEB, J. Regeneration from a Physico-Chemical View Point. McGraw-Hill Co. (1924).

MORGAN, T. H. Experimental Zoölogy. MacMillan and Co., New York (1917).

NEWMAN, H. H. The Physiology of Twinning. The University of Chicago Press (1923).

SIVICKIS, P. B. Studies on the physiology of reconstitution in Planaria lata, with a description of the species. Biol. Bull. 44 (1923).

SIVICKIS, P. B. A quantitative study of regeneration along the main axis of the triclad body. Arch. Zoöl. Italiano 16 (1931).

ILLUSTRATION

PLATE 1

FIG. 1. *Echinaster purpureus* Savigny, aboral view, with all the arms showing a sign of regeneration; × 0.5.

2. Oral view of the individual illustrated in fig. 1; × 0.5.
3. *Echinaster luzonicus* (Gray), aboral view of an individual with a bud connected abactinally; × 1.
4. *Echinaster luzonicus* (Gray), aboral view of one arm regenerating into a complete comet-shaped individual; × 1.
5. Oral view of the individual illustrated in fig. 4; × 1.
6. *Echinaster luzonicus* (Gray), aboral view of another comet-shaped individual. In both cases the regenerating disc and rays come from the proximal end of the arm; × 1.

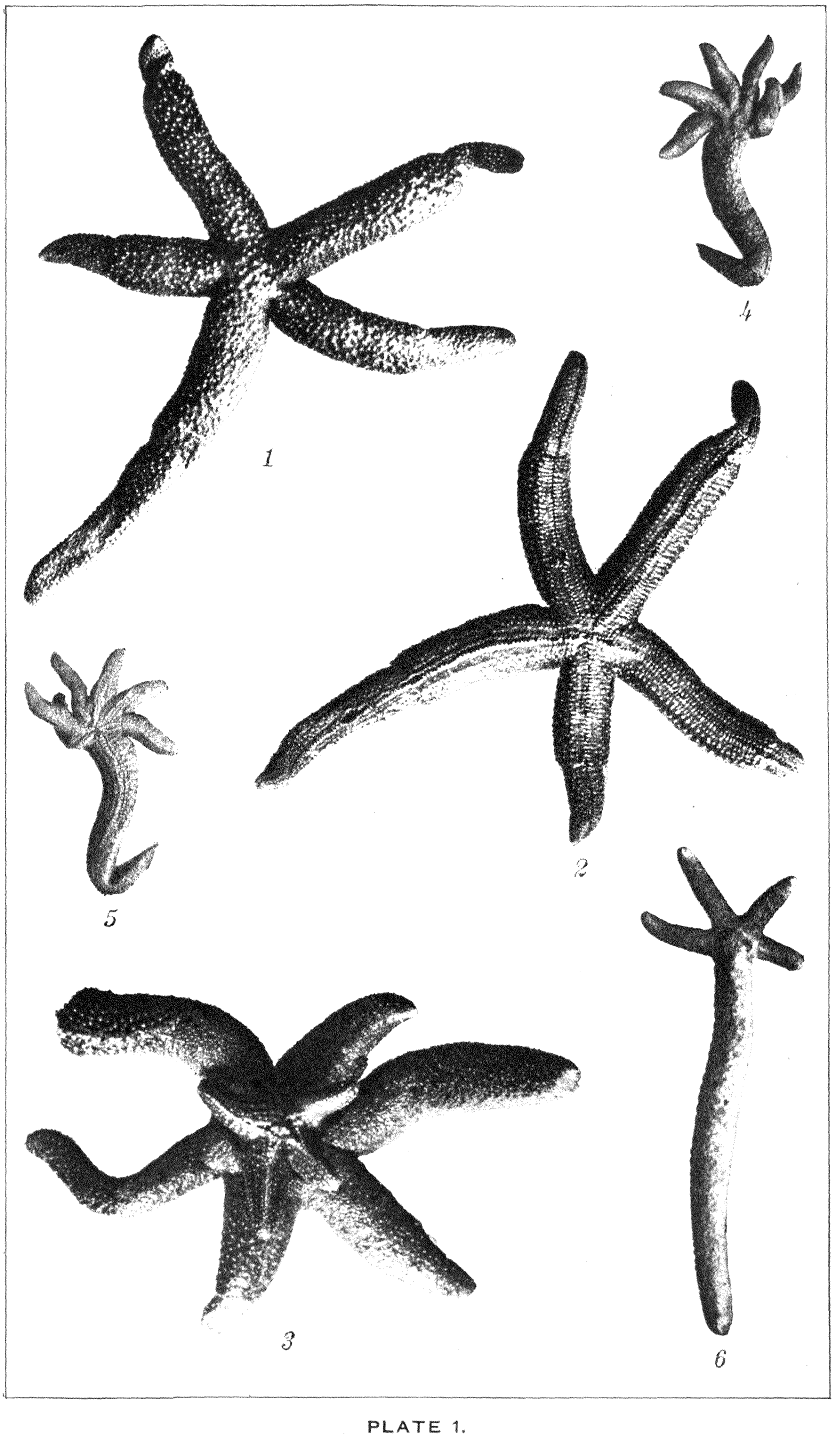

PLATE 1.

DIATOMS FROM THE PHILIPPINES, I

DIATOMS FROM DRINKING WATER, BALARA, RIZAL PROVINCE

By B. W. SKVORTZOW

Of Harbin, Manchoukuo

TWO PLATES

In 1936 Dr. Eduardo Quisumbing, curator of the Philippine National Herbarium, Manila, kindly sent me some diatom material collected by him in the Philippine Islands. The results of the identification of these diatoms will be published in a series of articles. The present note is the first of this series, and is based on a sample collected January 29, 1936, from filter No. 8 in Balara, Rizal Province. The brownish mucilaginous mass contained a great number of living diatoms of 42 different epiphytic forms, *Rhopalodia gibberula* var. *Heurckii* and *Rhopalodia Quisumbingiana* sp. nov. predominating. Almost all were fresh-water species, except *Rhopalodia gibberula* var. *van Heurckii* and *Nitzschia Clausii,* typical brackish-water species of which the former was abundant. *Rhopalodia Quisumbingiana* sp. nov. is probably also a brackish-water species. Almost all Balara diatoms were of a cosmopolitan nature, except several tropical species, as *Cymbella bengalensis* Grun., *Cymbella turgidula* Grun., *Surirella bengalensis* Grun., and *Cocconeis placentula* var. *euglypta.* The new species and varieties described here as new are *Achnanthes philippinica* sp. nov., *Navicula Hustedtii* Krasske fo. *philippina* fo. nov., *Navicula philippina* sp. nov., *Rhopalodia gibba* (Ehr.) O. Müll. var. *philippinica* var. nov., *Rhopalodia Quisumbingiana* sp. nov., *Nitzschia philippina* sp. nov., *Nitzschia philippina* sp. nov., *Nitzschia flexa* Schumann var. *philippina* var. nov. All the species and forms I have found are figured, and of new forms the Latin diagnoses are given. The diagrams were made by me with E. Leitz Apochromat 2 mm and Compens Ocular No. 4.

MELOSIRA VARIANS C. A. Agardh. Plate 1, fig. 34.

Melosira varians C. A. Agardh, FR. HUSTEDT, Bacillar. (1930) 85, 86, fig. 41.

Valve cylindrical, with smooth membrane. Height of valve 0.0255 mm; breadth, 0.017. Infrequent. Reported from fresh water.

CYMBELLA STELLIGERA Cleve and Grun. Plate 1, fig. 36.

Cymbella stelligera Cleve and Grun., FR. HUSTEDT, Bacillar. (1930) 100, fig. 65.

Valve circular, with radiating marginal striæ 15 in 0.01 mm. Central area with striæ forming a star. Diameter of the valve 0.011 mm. Common. A fresh-water species reported from littoral zones of lakes.

FRAGILARIA CROTONENSIS Kitton. Plate 1, fig. 9.

Fragilaria crotonensis Kitton, FR. HUSTEDT, Bacillar. (1930) 137, 138, fig. 125.

Valve linear-lanceolate, constricted from both sides in the middle part and gradually tapering to capitate ends. Length, 0.085 mm; breadth, 0.002. Striæ 15 to 18 in 0.01 mm. Infrequent. Reported from fresh-water lakes.

SYNEDRA ULNA (Nitzsch) Ehr. Plate 1, figs. 6 and 7; Plate 2, fig. 4.

Synedra ulna (Nitzsch) Ehr., FR. HUSTEDT, Bacillar. (1930) 151, 152, figs. 158, 159.

Valve linear, with subrostrate ends, or lanceolate, gradually tapering toward the acute ends. Length, 0.088 to 0.144 mm; breadth, 0.0055 to 0.0068. Striæ 8 to 10 in 0.01 mm. Common. A fresh-water species.

SYNEDRA ULNA (Nitzsch) Ehr. var **AEQUALIS** (Kütz.) Hustedt. Plate 2, fig. 1.

Synedra ulna (Nitzsch) Ehr. var. *aequalis* (Kütz.) FR. HUSTEDT, Bacillar. (1930) 152, fig. 164.

Valve very long, linear with broad rounded ends. Striæ not interrupted in the center by a vacant space. Length, 357 mm; breadth, 0.0068. Striæ 9 in 0.01 mm. Common. A fresh-water diatom.

SYNEDRA ACUS Kütz. var. **RADIANS** (Kütz.) Hustedt. Plate 2, fig. 2.

Synedra acus Kütz. var. *radians* (Kütz.) FR. HUSTEDT, Bacillar. (1930) 155, fig. 171.

Frustule very long, linear, almost imperceptibly attenuated towards the ends. Ends rounded. Central quadrangular space distinct. Length, 0.187 mm; breadth, 0.0025 at the middle, 0.0017 at the ends. Striæ fine, about 15 in 0.01 mm. Common. Reported from littoral zones of fresh-water lakes.

COCCONEIS PLACENTULA Ehr. var. **EUGLYPTA** (Ehr.) Cleve. Plate 1, figs. 35, 37, 43.

Cocconeis placentula Ehr. var. *euglypta* (Ehr.) Cleve, FR. HUSTEDT, Bacillar. (1930) 190, fig. 261; VAN HEURCK, Synopsis (1880) pl. 30, figs. 33, 34.

Valve broad-elliptic, with rounded ends. Length, 0.0085 to 0.025 mm; breadth, 0.0051 to 0.013. Upper valve crossed by 3 to 5 longitudinal, blank bands. Striæ 20 to 24 in 0.01 mm. Common. Var. *euglypta* is widely distributed in tropical regions. A fresh-water diatom.

ACHNANTHES MINUTISSIMA Kütz. Plate 1, fig. 5.

Achnanthes minutissima Kütz., FR. HUSTEDT, Bacillar. (1930) 198, fig. 274.

Valve linear-elliptic, with attenuate-rounded ends. Upper valve with linear filiform axial and central areas. Lower valve with very small suborbicular central area. Length, 0.12 mm; breadth, 0.0023. Striæ very fine, indistinct. Common. A fresh-water diatom.

ACHNANTHES MINUTISSIMA Kütz. var. CRYPTOCEPHALA Grun. Plate 1, figs. 11 and 12.

Achnanthes minutissima Kütz. var. *cryptocephala* Grun., FR. HUSTEDT, Bacillar. (1930) 198, fig. 275.

Differs from the type in its broader middle part and attenuate subcapitate ends. Length, 0.012 mm; breadth, 0.002 to 0.0022. Striæ indistinct. Common.

ACHNANTHES LANCEOLATA Breb. var. ROSTRATA Hust. Plate 1, fig. 24.

Achnanthes lanceolata Breb. var. *rostrata* FR. HUSTEDT, Bacillar. (1930) 208, fig. 306*b*.

Valve elliptic, with rostrate rounded ends. Upper valve with linear central and axial areas with a horse-shoe-shaped area on one side in the middle of valve. Lower valve with slightly dilated central area and subradiate striæ. Length, 0.0136 mm; breadth, 0.0051. Striæ 12 in 0.01 mm. Infrequent. A fresh-water diatom.

ACHNANTHES HAUCKIANA Grun. var. NIPPONICA Skv.? Plate 1, fig. 23.

Achnanthes Hauckiana Grun. var. *nipponica* SKVORTZOW, Diatoms from Biwa Lake, Honshu Island, Nippon (1936) pl. 6, fig. 12.

Valve broad-elliptic, with slightly attenuate, broad-rounded ends. Upper and lower valves with narrow linear central and axial areas. Length, 0.012 mm; breadth, 0.0034. Striæ radiate, 14 in 0.01 mm. Infrequent. Reported from Biwa Lake, Nippon.

ACHNANTHES PHILIPPINICA sp. nov. Plate 1, fig. 28.

Valvis ellipticis-attenuatis, cum polis rotundatis. Valva superior area axilares et centralis angusta linearis. Valva inferior raphe directa. Area axialli angustissima; area centrali transversaliter angustissima dilatata. Longis valvis 0.01 mm;

latis valvis 0.0025. Striæ circiter 30 in 0.01 mm. Habit. in aquis dulcis prope Balara, Rizal Province, Philippine Insul. Legit Dr. Quisumbing.

Valve elongate-elliptic, slightly attenuate, broad-rounded. Length, 0.01 mm; breadth, 0.0025. Upper valve with filiform central and axial areas. Lower valve with narrow linear axial area. Central area a short transverse fascia. Striæ very fine, parallel, about 30 in 0.01 mm. Infrequent. A species with the outline of *Achnanthes linearis* W. Smith.

DIPLONEIS OVALIS (Hilse) Cleve forma. Plate 1, fig. 46.

Diploneis ovalis (Hilse) Cleve, FR. HUSTEDT, Bacillar. (1930) 249, fig. 390.

Valve elliptic, with broad ends. Central nodule quadrate. Median line straight. Furrows narrow, closely following the central node. Structure-transverse rows of radiate distinct alveoli, 12 in 0.01 mm. Length, 0.029 mm; breadth, 0.014. Rare. The type has a broader central nodule. A fresh-water species.

DIPLONEIS PUELLA (Schumann) Cleve. Plate 1, fig. 22.

Diploneis puella (Schumann) Cleve, FR. HUSTEDT, Bacillar. (1930) 250, fig. 394.

Valve broad-elliptic with short, broad-rounded ends. Length, 0.0187 mm; breadth, 0.012. Central nodule quadrate, small; furrows very narrow, closely following the central nodule. Striæ radiate, 15 in 0.01 mm, with indistinct alveoli. Infrequent. Reported from fresh and brackish water.

STAURONEIS ANCEPS Ehr. Plate 2, fig. 6.

Stauroneis anceps Ehr., FR. HUSTEDT, Bacillar. (1930) 256, fig. 405.

Valve elliptic, gradually tapering from the middle to the subrostrate, acute ends. Length, 0.037 mm; breadth, 0.009. Striæ slightly radiate, more distinct in the middle part, in the middle about 20, at the ends, about 25, in 0.01 mm. Rare. A fresh-water diatom.

Genus NAVICULA Bory

NAVICULÆ MESOLEIÆ CLEVE

NAVICULA HUSTEDTII Krasske fo. PHILIPPINA fo. nov. Plate 1, fig. 44.

Differt a typo striis robustris. Longis valvis 0.0153 mm; latis 0.0051. Striæ 20 in 0.01 mm. Habit. in aquis dulcis prope Balara, Rizal Province, Philippine Insul. Legit Dr. E. Quisumbing.

Valve elliptic-lanceolate, with attenuate capitate ends. Length, 0.0153 mm; breadth, 0.0051. Axial area narrow linear; central broad and suborbicular. Striæ slightly radiate, 20 in 0.01 mm. Infrequent. Differs from the type in more robust striæ. The type is known from Europe in marshy waters.

NAVICULÆ ENTOLEIÆ CLEVE

NAVICULA CONTENTA Grun. fo. BICEPS Arnott. Plate 1, fig. 40.

Navicula contenta Grun. fo. *biceps* Arnott, FR. HUSTEDT, Bacillar. (1930) 277, fig. 458*c*.

Valve linear, constricted from both sides. Ends broad and subcapitate. Length, 0.01 mm; bread, 0.0034. Striæ very fine and indistinct. Infrequent. Reported from mountain districts on moist stones and in mosses.

NAVICULÆ MINUSCULÆ CLEVE

NAVICULA MINUSCULA Grun. Plate 1, fig. 41.

Navicula minuscula Grun., FR. HUSTEDT, Bacillar. (1930) 288, fig. 483.

Valve elliptic-lanceolate, with attenuate and subrostrate ends. Length, 0.011 mm; breadth, 0.0042. Striæ radiate, 18 in 0.01 mm. Differs from the type in the more robust striæ. Rare. Reported from fresh water and moist soil.

NAVICULÆ LINEOLATÆ CLEVE

NAVICULA CHYPTOCEPHALA Kütz. Plate 2, fig. 3.

Navicula cryptocephala Kütz., FR. HUSTEDT, Bacillar. (1930) 295, fig. 496.

Valve lanceolate, with attenuate, slightly subcapitate ends. Length, 0.024 mm; breadth, 0.0042. Striæ radiate, 18 to 20 in 0.01 mm. Infrequent. Reported from fresh and brackish water.

NAVICULA PHILIPPINA sp. nov. Plate 1, figs. 25 and 45.

Valvis lanceolatis cum polis subacutis. Area axilaris anguste lineatis; centralis modice dilatate. Raphe directa. Striis radiantes, 10 ad 14 in 0.01 mm, non convergentibus. Longis valvis 0.0204 ad 0.0255 mm; latis 0.005. Habit. in aquis dulcis prope Balara, Rizal Province, Philippine Insul. Legit Dr. E. Quisumbing.

Valve lanceolate, gradually tapering from the middle to the acute ends. Length, 0.0204 to 0.0255 mm; breadth, 0.005. Axial area narrow, linear; central subordicular. Raphe straight. Striæ radiate, 10 to 11 in 0.01 mm. Infrequent. Akin to *Navicula simplex* Krasske.

NAVICULA MENISCULUS Schumann. Plate 2, fig. 8.

Navicula menisculus Schumann, FR. HUSTEDT, Bacillar. (1930) 301, fig. 517.

Valve elliptic-lanceolate with attenuate acute ends. Length, 0.0153 mm; breadth, 0.005. Axial area narrow, central suborbicular. Striæ radiate, divergent in the middle and slightly convergent at the ends, 12 to 14 in 0.01 mm and not lineolate. Rare. Reported from fresh and brackish water.

PINNULARIA MESOLEPTA (Ehr.) W. Smith. Plate 1, fig. 14.

Pinnularia mesolepta (Ehr.) W. Smith, FR. HUSTEDT, Bacillar. (1930) 319, fig. 575*a*.

Valve linear, triundulate with capitate ends. Length, 0.0629 mm; breadth, 0.01. Striæ radiate, divergent in the middle and convergent at the ends, 9 in 0.01 mm. Central area a broad fascia. Rare. Reported from fresh water.

CYMBELLA BENGALENSIS Grun. Plate 2, fig. 9.

Cymbella bengalensis Grun., A. SCHMIDT, Atlas Diatom. (1875–1931) pl. 9, figs. 12, 13; pl. 71, fig. 29; pl. 375, fig. 3.

Cymbella aspera Ehr. var. *bengalensis* Grun., CLEVE, Synopsis of the Naviculoid Diatoms (1894) 1, 176.

Valve boat-shaped, with strongly arcuate dorsal margin and centrally gibbous ventral margin. Ends obtuse, rounded. Length, 0.093 to 0.105 mm; breadth, 0.00255 to 0.027. Striæ ventral 10 to 11, dorsal 8 in 0.01 mm. Puncta 14 to 16 in 0.01 mm. Median line slightly arcuate. Axial area linear, scarcely dilated around the central nodule. Infrequent. Reported from Bengal and Sacotra.

CYMBELLA TURGIDULA Grun. Plate 2, fig. 11.

Cymbella turgidula Grun., FR. HUSTEDT, Bacillar. (1930) 362, fig. 670; A. SCHMIDT, Atlas Diatom. (1931) pl. 376, figs. 8–13.

Valve asymmetrical, boat-shaped, arcuate at dorsal and slightly convex at ventral margins. Ends subrostrate. Length, 0.0391 mm; breadth, 0.011. Striæ ventral 7, dorsal 8 in 0.01 mm. At the ventral side of the central nodule are two small puncta, ending the median striæ. Infrequent. Common in tropical districts.

CYMBELLA VENTRICOSA Kütz. Plate 1, figs. 21, 38, 39, and 42.

Cymbella ventricosa Kütz., FR. HUSTEDT, Bacillar. (1930) 359, fig. 661.

Valve boat-shaped, asymmetrical with acute dorsal and moderately convex ventral margins. Median line about straight. Axial and central area very narrow. Striæ radiate, ventral and

dorsal 12 in 0.01 mm. Length, 0.012 to 0.015 mm; breadth, 0.034 to 0.042. Very common. A fresh-water species.

GOMPHONEMA LANCEOLATUM Ehr. Plate 1, fig. 31; Plate 2, fig. 12.

Gomphonema lanceolatum Ehr. FR. HUSTEDT, Bacillar. (1930) 376, fig. 700.

Valve lanceolate, clavate, with the apex broader than the basis. Length, 0.0238 to 0.0425 mm; breadth, 0.0062 to 0.0085. Striæ radiate, 9 to 11 in 0.01 mm. Infrequent. A fresh-water diatom.

EPITHEMIA SOREX Kütz. Plate 1, fig. 15.

Epithemia sorex Kütz., FR. HUSTEDT, Bacillar. (1930) 388, fig. 736.

Valve lunate, with arcuate dorsal and constricted ventral margins. Ends attenuate and capitate. Length, 0.0476 mm; breadth, 0.0119. Costæ 5, striæ 12 in 0.01 mm. Rare. Reported from fresh water.

EPITHEMIA ZEBRA (Ehr.) Kütz. Plate 1, fig. 13; Plate 2, figs. 10 and 16.

Epithemia zebra (Ehr.) Kütz., FR. HUSTEDT, Bacillar. (1930) 384, 385, fig. 729.

Valve lunate, arcuate. Ventral part slightly constricted and the ends moderately attenuate and rounded. Length, 0.0357 to 0.056 mm; breadth, 0.0085 to 0.013. Costæ 2 to 4, rows of granules 8 to 10 in 0.01 mm. Infrequent. Reported from fresh water.

RHOPALODIA GIBBA (Ehr.) O. Müll. Plate 1, fig. 26.

Rhopalodia gibba (Ehr.) O. Müll., FR. HUSTEDT, Bacillar. (1930) 490, fig. 740.

Valve from the front view sublanceolate, slightly arcuate and reflexed on the dorsal and straight on the ventral margins. Length, 0.076 mm; breadth, 0.019. Costæ 7, striæ 14 in 0.01 mm. Common. A fresh-water diatom.

RHOPALODIA GIBBA (Ehr.) O. Müll. var. **VENTRICOSA** (Ehr.) Grun. Plate 1, fig. 17.

Rhopalodia gibba (Ehr.) O. Müll. var. *ventricosa* (Ehr.) Grun., FR. HUSTEDT, Bacillar. (1930) 391, fig. 741.

Valve from the front view sublanceolate, with arcuate and reflexed dorsal margin and attenuate reflexed ends. Ventral side straight. Length, 0.055 mm; breadth, 0.022. Costæ 8, striæ 16 in 0.01 mm. Infrequent. Common in fresh water.

RHOPALODIA GIBBA (Ehr.) O. Müll. var. **PHILIPPINICA** var. nov. Plate 1, figs. 16 and 20; Plate 2, fig. 17.

Differt a typo valvis dorsale triundulatis. Longis valvis 0.098 ad 0.115 mm; latis 0.022 ad 0.024. Costæ 6 ad 7, striis

12 ad 14 in 0.01 mm. Habit. in aquis dulcis prope Balara, Rizal Province, Philippine Insul. Legit Dr. E. Quisumbing.

Valve from front view linear and triundulate. Ventral side straight. Length, 0.098 to 0.115 mm; breadth, 0.022 to 0.024. End breadth, 0.013 mm. Costæ 6 to 7, striæ 12 to 14 in 0.01 mm. Differs from the type in its triundulate dorsal margin. Infrequent.

RHOPALODIA GIBBERULA (Ehr.) O. Müll. var. VAN HEURCKII O. Müll. Plate 1, figs. 27, 29, and 30.

Rhopalodia gibberula (Ehr.) O. Müll. var. *van Heurckii* O. Müll., A. SCHMIDT, Atlas Diatom. (1905) pl. 255, figs. 13, 15, 21.

Valve from the front view moon-shaped, arcuate at dorsal margin, and straight at ventral. Ends reflexed. Length, 0.01 to 0.0306 mm; breadth, 0.018 to 0.0204. Costæ slightly radiate, 2 to 3, striæ 12 in 0.01 mm, punctate. Puncta 12 to 13 in 0.01 mm. Abundant. A brackish-water diatom.

RHOPALODIA QUISUMBINGIANA sp. nov. Plate 1, figs. 1 to 4; Plate 2, figs. 13 and 14.

Frustulis elongate-elliptisis, modice spiralis, cum polis subacutis, rotundatis.

Valvis linaribus modice lunatis et inflexis; dorso tumidis ad medium interruptis; ventre directis. Costæ ad medium valvis parallelis, ad polis radiantes, 5 ad 7; striis 14 ad 15 in 0.01 mm, ad marginem ventre cum series punctorum minoris ornata. Longis valvis 0.047 ad 0.127 mm; latis 0.018 ad 0.022. Costæ 5 ad 7; striis 14 ad 15 in 0.01 mm. Habit. in aquis dulcis prope Balara, Rizal Province, Philippine Insul. Legit Dr. E. Quisumbing.

Frustule from the front view elongate-elliptic, asymmetrical, slightly and distinctly spirally curved, with one end slightly broader than the other.

Valve lunate, slightly reflexed at the extremities, with long curved ends and small single dots on the median marginal interruption. Ventral side almost straight, punctate along the margin. Costæ and striæ parallel on the middle, radiate at both ends. Length, 0.047 to 0.1275 mm; breadth, 0.018 to 0.025. Costæ 5 to 7, striæ 14 to 15 in 0.01 mm. Common. Differs from *Rhopalodia parallela* (Grun) O. Müll. in the more ovoid frustules and the spiral curve, and from *Rhopalodia gracilis* O. Müll., a species reported from western Africa, in the curved valves and in the presence of a median marginal interruption with a dot. Named in honor of Dr. E. Quisumbing, curator, Philippine National Herbarium, Manila, Philippines.

NITZSCHIA GRACILIS Hantzsch. Plate 1, fig. 8; Plate 2, fig. 5.

Nitzschia gracilis Hantzsch, A. SCHMIDT, Atlas Diatom. (1924) pl. 349, figs. 35, 37.

Valve linear-filiform, gradually tapering from the middle to the apiculate ends. Length, 0.0306 to 0.0357 mm; breadth, 0.0017 to 0.002. Costæ 12 to 15 in 0.01 mm. Striæ very fine, indistinct. Common. A fresh-water diatom.

NITZSCHIA PHILIPPINA sp. nov. Plate 1, fig. 32.

Valvis angustis-linearibus, ad marginem parallelis, cum polis subacutis, rotundatis. Punctis carinalibus minimus, 10 ad 11 in 0.01 mm. Striis delicatis, inconspicuis. Longis valvis 0.091 mm; latis 0.0034. Habit. in aquis dulcis prope Balara, Rizal Province, Philippine Insul. Legit Dr. E. Quisumbing.

Valve linear or linear-lanceolate, with parallel margins and slightly attenuate and acute ends. Length, 0.0918 mm; breadth, 0.0034. Costæ 10 to 11 in 0.01 mm. Striæ very fine and indistinct. Infrequent. A species of the outline of *Nitzchia frustulum* (Kütz.) Grun. but with indistinct striæ. The related species are *Nitzschia subtilis* (Kütz.) Grun. and *Nitzchia Nikitiana* sp. nov. from northern Manchuria.

NITZSCHIA PALEA (Kütz.) W. Smith. Plate 1, figs. 19 and 33.

Nitzschia palea (Kütz.) W. Smith, A. SCHMIDT, Atlas Diatom. (1924) pl. 349, figs. 1–10.

Valve linear-lanceolate, parallel in the middle part and attenuate acute at the ends. Length, 0.0255 to 0.0272 mm; breadth, 0.0032 to 0.0034. Costæ 12 in 0.01 mm. Striæ indistinct. Common. A fresh-water diatom.

NITZCHIA FLEXA Schumann var. **PHILIPPINICA** var. nov. Plate 1, fig. 47.

Valvis gracilioribus, minoribus et brevioribus quam species. Longis valvis 0.04 ad 0.0425 mm; latis 0.0017 ad 0.0019. Costæ 12. Striis inconspicuis. Habit. in aquis dulcis prope Balara, Rizal Province, Philippine Insul. Legit Dr. E. Quisumbing.

Valve front view linear, sigmoid, with parallel margins. Length, 0.04 to 0.0425 mm; breath, 0.0017 to 0.0019. Costæ 12 in 0.01 mm. Infrequent. Smaller and shorter than the type. *Nitzschia flexa* is reported from fresh waters of Europe.

NITZSCHIA SIGMOIDEA (Ehr.) W. Smith? Plate 2, fig. 7.

Nitzschia sigmoidea (Ehr.) W. Smith, FR. HUSTEDT, Bacillar. (1930) 419, fig. 810.

Valve front view linear-sigmoid, with slightly attenuate and obtuse ends. Length, 0.14 mm; breadth, 0.008. Costæ 7, striæ about 25 to 0.01 mm. Rare. A fresh-water species.

NITZSCHIA CLAUSII Hantzsch. Plate 1, fig. 18.

Nitzschia Clausii Hantzsch, FR. HUSTEDT, Bacillar. (1930) 421, fig. 814; A. SCHMIDT, Atlas Diatom. (1921) pl. 336, figs. 7–11.

Valve linear-lanceolate, with sigmoid ends. Margin parallel. Ends attenuate and slightly capitate. Length, 0.0425 mm; breadth, 0.0034. Costæ 0 in 0.01 mm. Striæ very fine, indistinct. Infrequent. A brackish-water diatom.

NITZSCHIA ACICULARIS W. Smith. Plate 1, fig. 10.

Nitzschia acicularis W. Smith, FR. HUSTEDT, Bacillar. (1930) 423, fig. 821; A. SCHMIDT, Atlas Diatom. (1921) pl. 335, figs. 15–17.

Valve linear-lanceolate, with almost parallel margins and attenuate, long, filiform ends. Length, 0.076 mm; breadth, 0.0034. Costæ 15 to 17 in 0.01 mm. Striæ also indistinct. Infrequent. Reported from fresh water.

SURIRELLA BENGALENSIS Grun. Plate 2, fig. 18.

Surirella bengalensis Grun., A. SCHMIDT, Atlas Diatom. (1875) pl. 24, fig. 16; MEISTER, Beiträge zur Bacillar. Japans 11 (1914) 229, pl. 8, figs. 11–13; SKVORTZOW, Diatoms from Chengtu, Szechwan, Western China, pl. 3, fig. 20.

Valve broad-ovate, with distinct, broad outer rim and costæ not reaching the pseudoraphe. Marginal keel forming wings. Length, 0.076 mm; breadth, 0.039. Costæ 3 in 0.01 mm. Infrequent. Reported from Bengal, India, from Tokyo, Nippon, and recently from Chengtu, Western China.

SURIRELLA CAPRONII Breb. Plate 2, fig. 15.

Surirella Capronii Breb., FR. HUSTEDT, Bacillar. (1930) 440, fig. 857.

Valve narrow-ovate, with one end much broader than the other. Marginal keel forming wings or alæ seen in zone view. Costæ distinct, about reaching the pseudoraphe. Central area linear and smooth. Two distinct spines near each end. Length, 0.047 to 0.17 mm; breadth, 0.017 to 0.056 mm. Costæ 2 to 4 in 0.01 mm. Common. Reported from fresh water.

LITERATURE CITED

CLEVE, P. T. Synopsis of the Naviculoid Diatoms. Stockholm (1894–1895).

HUSTEDT, FR. Bacillariophyta. Jena (1930).

MEISTER, FR. Beiträge zur Bacillariaceenflora Japans, 11. Archiv für Hydrob. und Plankt. 9 (1913–1914).

SCHMIDT, A. Atlas der Diatomaceenkunde. Leipzig (1875–1831).

SKVORTZOW, B. Diatoms from Biwa Lake, Honchu Island, Nippon. Philip. Journ. Sci. 61 (1936) 253.

VAN HEURCK, H. Synopsis des Diatomees belguiques. Anvers (1880–1881).

ILLUSTRATIONS

PLATE 1

FIGS. 1 to 4. *Rhopalodia Quisumbingiana* sp. nov.
FIG. 5. *Achnanthes minutissima* Kütz.
FIGS. 6 and 7. *Synedra ulna* (Nitzsch) Ehr.
FIG. 8. *Nitzschia gracilis* Hantzsch.
9. *Fragilaria crotonensis* Kitton.
10. *Nitzschia acicularis* W. Smith.
FIGS. 11 and 12. *Achnanthes minutissima* Kütz. var. *cryptocephala* Grun.
FIG. 13. *Epithemia zebra* (Ehr.) Kütz.
14. *Pinnularia mesolepta* (Ehr.) W. Smith.
15. *Epithemia sorex* Kütz.
16. *Rhopalodia gibba* (Ehr.) O. Müll. var. *philippinica* var. nov.
17. *Rhopalodia gibba* (Ehr.) O. Müll. var. *ventricosa* (Ehr.) Grun.
18. *Nitzschia Clausii* Hantzsch.
19. *Nitzschia palea* (Kütz.) W. Smith.
20. *Rhopalodia gibba* (Ehr.) O. Müll. var. *philippinica* var. nov.
21. *Cymbella ventricosa* Kütz.
22. *Diploneis puella* (Schum.) Cleve.
23. *Achnanthes Hauckiana* Grun. var. *nipponica* Skv.?
24. *Achnanthes lanceolata* Breb. var. *rostrata* Hust.
25. *Navicula philippina* sp. nov.
26. *Rhopalodia gibba* (Ehr.) O. Müll.
27. *Rhopalodia gibberula* (Ehr.) O. Müll. var. *van Heurckii* O. Müll.
28. *Achnanthes philippinica* sp. nov.
FIGS. 29 and 30. *Rhopalodia gibberula* (Ehr.) O. Müll. var. *van Heurckii* O. Müll.
FIG. 31. *Gomphonema lanceolatum* Ehr.
32. *Nitzschia philippina* sp. nov.
33. *Nitzschia palea* (Kütz.) W. Smith.
34. *Melosira varians* C. A. Ag.
35. *Cocconeis placentula* Ehr. var. *euglypta* (Ehr.) Cleve.
36. *Cymbella stelligera* Cleve and Grun.
37. *Cocconeis placentula* Ehr. var. *euglypta* (Ehr.) Cleve.
FIGS. 38 and 39. *Cymbella ventricosa* Kütz.
FIG. 40. *Navicula contenta* Grun. fo. *biceps* Arnott.
41. *Navicula minuscula* Grun.
42. *Cymbella ventricosa* Kütz.
43. *Cocconeis placentula* Ehr. var. *euglypta* (Ehr.) Cleve.
44. *Navicula Hustedtii* Krasske fo. *philippina* fo. nov.
45. *Navicula philippina* sp. nov.
46. *Diploneis ovalis* (Hilse) Cleve.
47. *Nitzschia flexa* Schum. var. *philippinica* var. nov.

PLATE 2

FIG. 1. *Synedra ulna* (Nitsch) Ehr. var. *aequalis* (Kütz.) Hust.
2. *Synedra acus* Kütz. var. *radians* (Kütz.) Hust.
3. *Navicula cryptocephala* Kütz.
4. *Synedra ulna* (Nitzsch) Ehr.
5. *Nitzschia gracilis* Hantzsch.
6. *Stauroneis anceps* Ehr.
7. *Nitzschia sigmoidea* (Ehr.) W. Smith?
8. *Navicula menisculus* Schum.
9. *Cymbella bengalensis* Grun.
10. *Epithemia zebra* (Ehr.) Kütz.
11. *Cymbella turgidula* Grun.
12. *Gomphonema lanceolatum* Ehr.

FIGS. 13 and 14. *Rhopalodia Quisumbingiana* sp. nov.

FIG. 15. *Surirella Capronii* Breb.
16. *Epithemia zebra* (Ehr.) Kütz.
17. *Rhopalodia gibba* (Ehr.) O. Müll. var. *philippinica* var. nov.
18. *Surirella bengalensis* Grun.

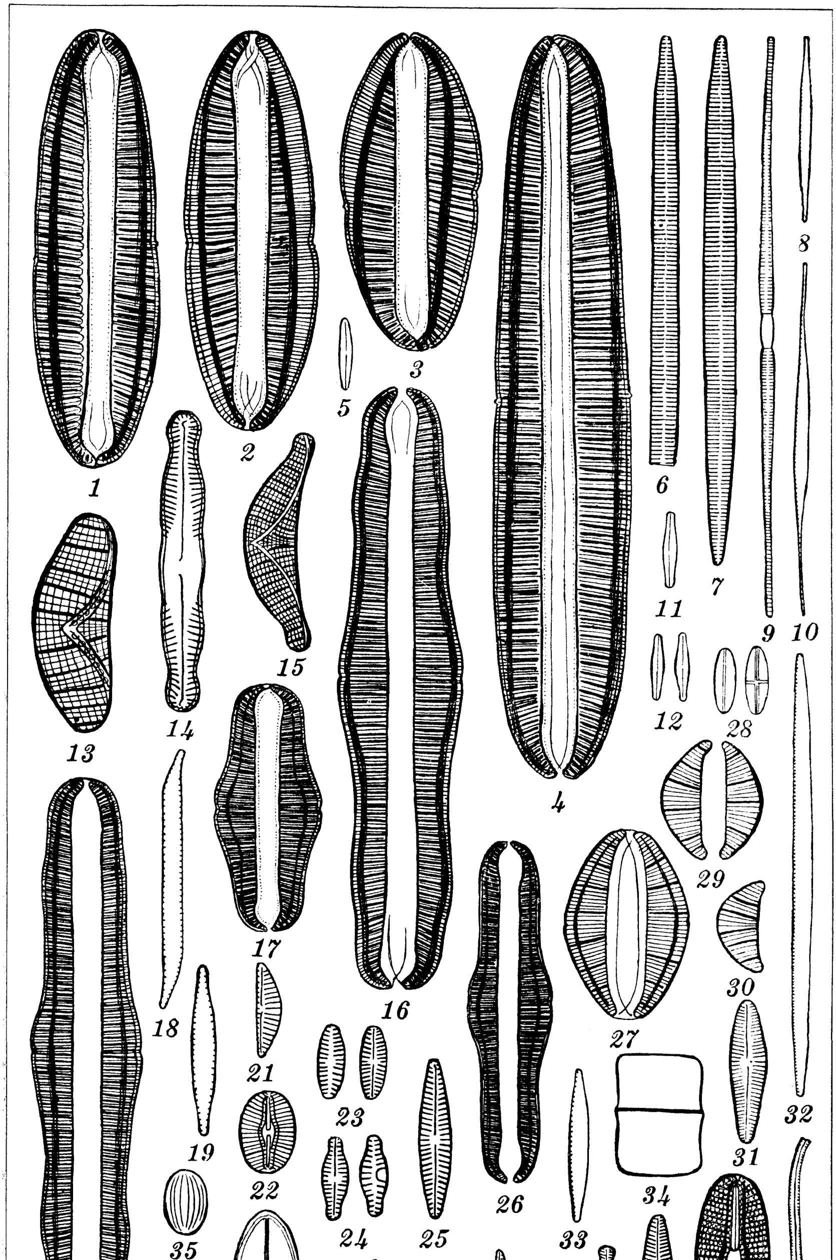
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PLATE 1.

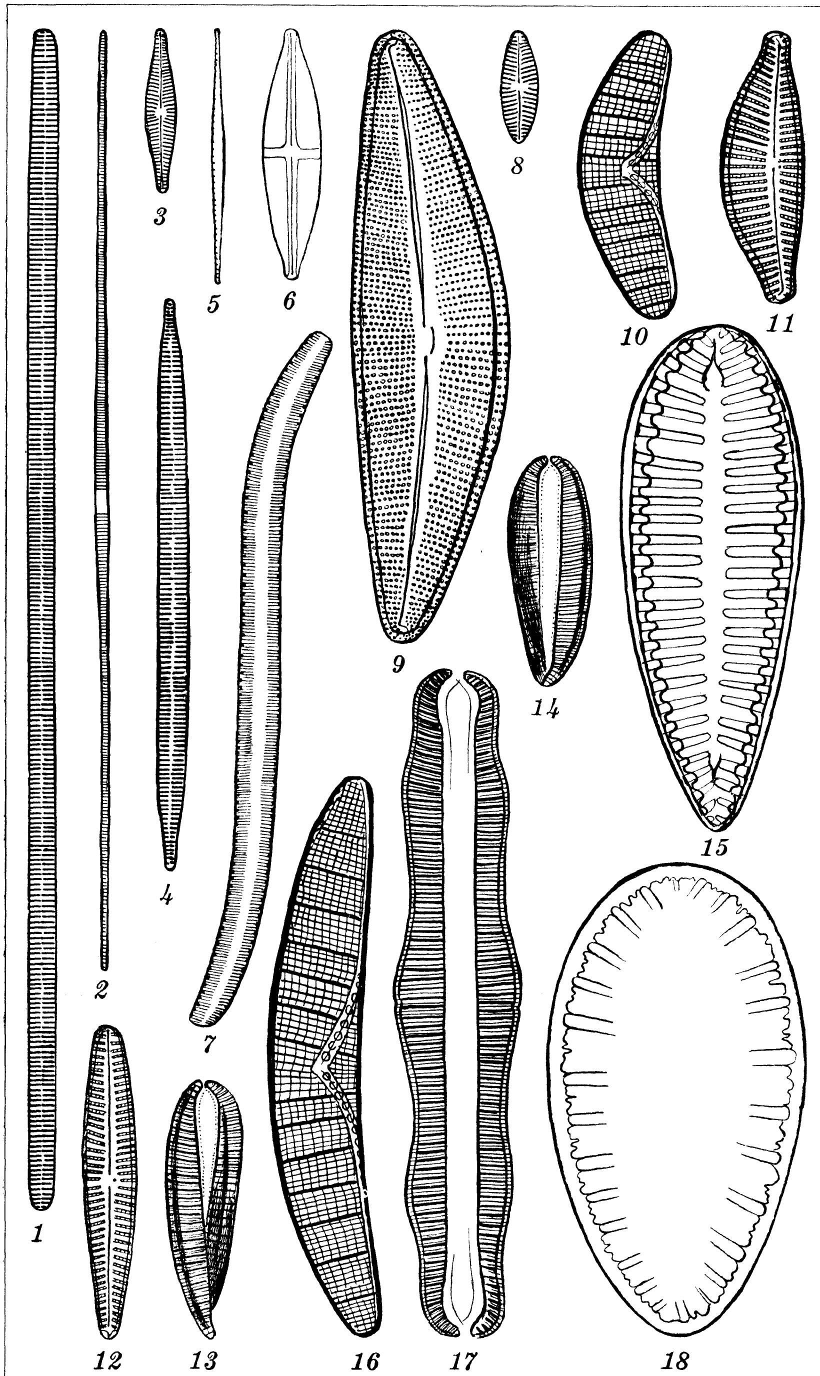

PLATE 2.

THE NAUCORIDÆ OF THE PHILIPPINE ISLANDS (HEMIPTERA)

By Robert L. Usinger

Of the University of California

ONE PLATE AND TWO TEXT FIGURES

The present paper is based largely on material collected by myself in Luzon, during a brief visit in July, 1936. My thanks are due to Mr. G. Bellosillo and Dr. Fidel del Rosario for a very profitable field trip to Montalban in Rizal Province, and to Drs. S. M. Cendaña and L. B. Uichanco, who contributed so largely to the success of my visit to Los Baños and Mount Maquiling in Laguna Province. Mrs. Frieda Abernathy meticulously executed figures 1 to 4, while the genitalia drawings were made by me.

Two species of the hemipterous family Naucoridæ have heretofore been recorded from the Philippine Islands. Both of these, *Naucoris obscuripennis* Stål (1854) and *N. seminiger* Lethierry (1877), were described from Manila and have not been compared with each other. They are discussed below, together with three apparently new species. The new species are of considerable significance, as they extend both the scope and the known distribution of their respective subfamilies considerably. Further significance of these collections lies in the suggestion of a rich and as yet untouched fauna in the more remote provinces of Luzon and on the other islands of the Philippine Archipelago. It becomes obvious that these interesting water bugs are of frequent occurrence in the Philippines, and it is hoped that collectors will devote more time to them in the future than has been their wont in the past.

NAUCORINÆ

NAUCORIS OBSCURIPENNIS Stål. Text fig. 1.

Naucoris obscuripennis Stål, Öfv. Vet.-Akad. Förh. 11 (1854) 239; Freg. Eugen. Resa, Ins. (1859) 266; Enum. Hemipt. 5 (1876) 145.
Naucoris seminiger Lethierry, Bull. Soc. Ent. Franc. (5) 7 (1877) ci.

A single specimen collected in Molawin Creek on the Los Baños campus, July 17, 1936, in a quiet pool beneath some floating, dead vegetation. It is 7 millimeters long. The em-

bolium is pale, not only at the base, but along the entire margin, with the exception of apical sixth. The lateral pronotal margins anteriorly have a distinct, sinuate, black vitta extending from behind the eyes to the lateral margins. The mesosternum is strongly carinate at the center, the carina platelike, composed of a smaller anterior and a larger posterior lobe, rounded in profile and more strongly elevated posteriorly.

This specimen is smaller than Stål specified for his type (8 millimeters) and smaller than Lethierry's *seminiger* (7.5 millimeters). The black anterolateral pronotal markings would place it as *scutellaris* Stål in Stål's key (1876) but Lundblad has re-

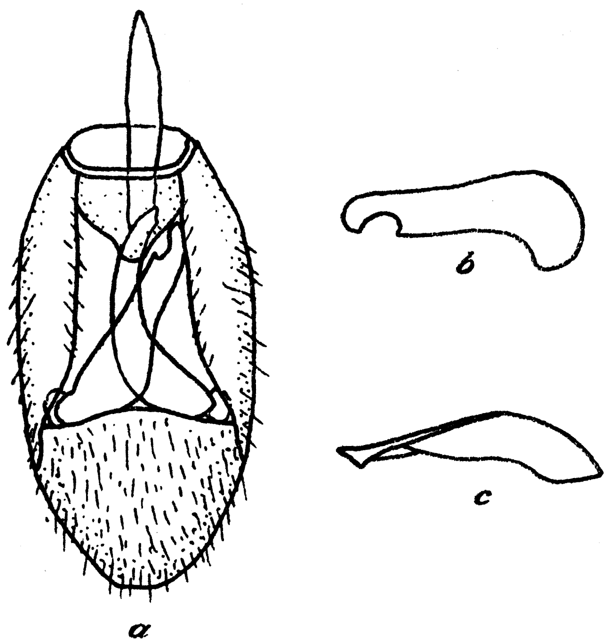

FIG. 1. *Naucoris obscuripennis* Stal, male genitalia. *a*, Genital capsule, dorsal view; *b*, left paramere; *c*, right paramere.

cently shown (1933) that *scutellaris* is exceedingly variable, synonymizing Distant's *sordidus, vividus, greeni,* and *clathratus* with it. Such variation in a single species is indeed remarkable, and certainly minimizes the importance of color as a diagnostic character in this group. Other differences between *obscuripennis* and *scutellaris* are the smaller size of *scutellaris* (5 to 6 millimeters) and the male genitalia (text fig. 1) which, upon comparison with Lundblad's figures (1933, fig. 19), are seen to differ in certain respects. In *obscuripennis* the capsule (text fig. 1, *a*) is less narrowed and less strongly produced posteriorly, and the left paramere (text fig. 1, *b*) is differently

shaped and has fewer and smaller spines within the margin subapically. Considering their geographical distribution and apparently insignificant color and size differences, I venture to suggest that *obscuripennis* Stål is identical with *seminiger* Lethierry, although I have not examined either of the types.

NAUCORIS spp.

Three nymphs that may belong here were collected in swiftly flowing water of the river at Montalban Gorge. They were taken by disturbing rocks upstream and allowing the bugs to be swept down into the net. A single nymph of still another species was taken in some still water nearby.

CHEIROCHELINÆ

Genus ASTHENOCORIS Usinger novum

Oblong with sides subparallel. Superficially rugosely punctate. Head strongly produced beyond level of anterior margins of eyes; rather deeply inserted into anterior margin of pronotum which is trimarginate. Rostrum deeply inserted at base of a profound excavation of anterior half of head, the anterior portion of head extending as a plate beyond the much reduced, strongly transverse, apically rounded labrum. Subgenal plates prominent, forming elevated, anteriorly divergent continuations of the rounded posterior margin of the rostral excavation; exceeding tip of labrum but not extending anteriorly to anterior margin. Gula subacutely carinate at middle, tectiform. Antennæ very slender, proportion of segments 1 to 4 as 1.5: 2.5: 3.5: 4, the first two segments thickest, shining, third and fourth segments linear, densely hairy. Eyes scarcely twice as long as greatest width, feebly lamellately produced laterally. Disc of head above with outline of base of rostrum visible, with a pair of oblique longitudinal lines on vertex, as in other members of the family.

Pronotum transverse, with lateral margins entire and posterolateral angles rounded. Disc with characteristic anterior depression ill-defined at middle, its sides anteriorly divergent but not reaching level of inner margins of eyes. An ill-defined longitudinal arcuate fascia behind each eye. A feeble subbasal transverse depression especially poorly indicated at middle. Hemelytra variously developed, entire to greatly reduced; when fully developed with a distinct clavus and embolium and with the membrane set apart from shagreened corium mainly by its shiny, subdepressed surface. Connexivum evenly rounded, the angles not or scarcely prominent laterally. Prosternum strongly

elevated and carinate anteriorly, widened and depressed posteriorly; exposed throughout its entire length, the short, scarcely produced propleural plates scarcely covering its sides (Plate 1, fig. 2). Venter densely clothed with fine, moderately long hairs.

Front femora tremendously broad, three-fourths as broad as long. Anterior tarsi one-segmented, with a single extremely minute and very blunt claw at apex of each; both the tarsus and claw scarcely distinguished from arcuate tibia. Intermediate and posterior tibiæ with several rows of short, tawny spines, the posterior tibiæ, moreover, with dense swimming hairs on their dorsal surfaces. Intermediate and posterior tarsi each with two claws.

Genotype: *Asthenocoris luzonensis* Usinger sp. nov.

This genus is very different in general aspect from either *Cheirochela* or *Gestroiella*. It may be readily distinguished from both of these by its simple connexival angles, rounded posterolateral pronotal angles, and less strongly developed front legs. It is allied to the Bornean *Coptocatus* Montandon, from which it may be distinguished by its blunt, scarcely produced anterolateral pronotal angles, rounded sides of pronotum, distinct although greatly reduced labrum, and much smaller size. This interesting genus requires an enlargement of our concept of the subfamily Cheirochelinæ. The absence of a labrum was evidently an all-important consideration of Montandon's in thinking of this group. The present species, however, has the characteristic prolongation of the head, with the rostrum set in a deep excavation remote from its apex, while the labrum is moderately developed. I suspect from the description that Montandon's genus *Idiocarus* likewise belongs here. In *Idiocarus* the labrum is reduced and is concealed by the anterior prolongation of the head. The strongly produced subgenal plates considered to be of such great importance by Montandon in associating the genus with *Cryphocricos* are present, although variously developed, in all members of the family. They are prominent in *Asthenocoris*. This character then becomes merely one of degree, as in the American genera included in the Cryphocricinæ. That Montandon had only a hazy idea of the Cryphocricinæ is shown by his inclusion of *Pseudambrysus* (described on the next page to *Idiocarus*) in his monograph of the "Cryphocricinæ." He later (1897) concluded that *Pseudambrysus* was little more than a subgenus of *Macrocoris* in the subfamily Naucorinæ. Distribution lends added weight to

this theory, as *Idiocarus* at present is monotypic and is the only representative of the great *Cryphocricus-Ambrysus* group recorded from the Eastern Hemisphere. A study of Montandon's type will, of course, settle the question.

ASTHENOCORIS LUZONENSIS Usinger sp. nov. Plate 1, figs. 1 and 2; text fig. 2.

Oblong-oval with subparallel sides. Head transverse, 27: 19, slightly longer than width of interocular space behind, 19: 18; the inner margins of eyes straight, converging anteriorly; ratio of posterior to anterior interocular widths 9: 7; almost as

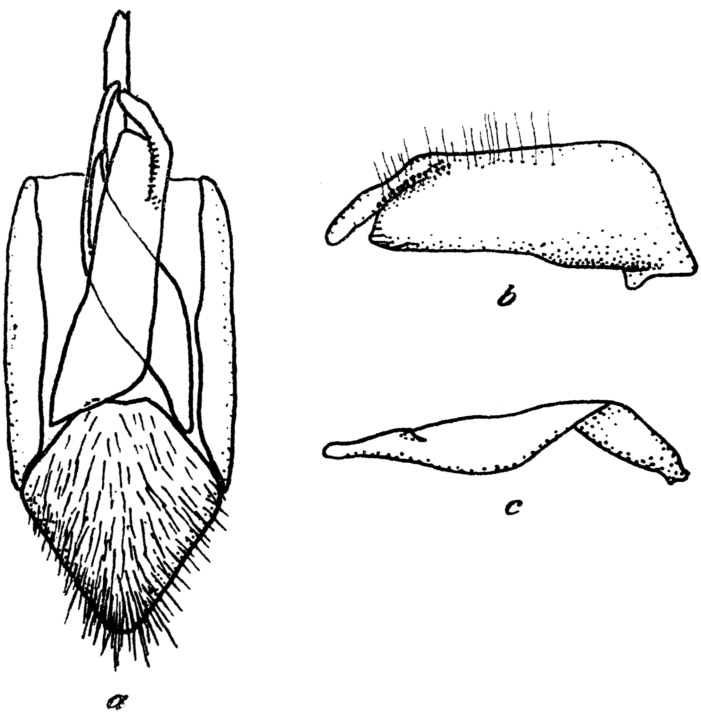

FIG. 2. *Asthenocoris luzonensis* sp. nov., male genitalia. *a*, Genital capsule, dorsal view; *b*, left paramere; *c*, right paramere.

strongly produced before the eyes as posterior insertion into pronotum behind the eyes, 4: 5; disc moderately elevated basally and at middle, depressed anterolaterally and on anterior prolongation which is rounded anteriorly. Eyes a little less than twice as long as broad, broadest posteriorly where they are broadly rounded, subacute anteriorly; anterolateral margins feebly arcuate, very slightly but distinctly lamellately produced laterally over anterior angles of pronotum. Pronotum only

moderately convex, transverse, about one and one-half times as broad posteriorly as head including eyes; a little less than three times as broad as long; anterior angles almost right angles; sides strongly arcuate and narrowly carinate; posterolateral angles broadly rounded, subemarginate at level of emboliar margins; surface irregularly, very superficially punctate, transversely rugose anteriorly at middle; anterior border behind interocular space distinctly margined or ledged. Scutellum twice as broad as long, subbasally transversely depressed, sides feebly sinuate, disc irregularly, finely, rugosely punctate. Hemelytra not reaching apex of abdomen, scarcely exceeding apex of posteriorly produced, apically shallowly emarginate fifth abdominal segment, which is transversely rugose above. Commissure of clavus about one-third as long as scutellum. Embolium abruptly dilated at base, then subrectilinear and scarcely dilated to posterior third where it is broadly rounded and thence distinctly sinuate at joining with corium. Connexivum broadly exposed, the posterolateral angles right angles. Male genital capsule (text fig. 2, *a*) elongate-oval, rounded at apex, and with the median basal, dorsal lobe very short and moderately produced at middle. Parameres very prominent, asymmetrical, the left paramere (text fig. 2, *b*) with a rounded notch subapically and the right paramere (text fig. 2, *c*) angulately truncate at apex.

Color black, the interocular space except basally, pronotum except anteriorly and behind transverse impression, very narrow emboliar margin, commissure of clavus, connexivum obscurely except on posterior angles and narrow fulvous margins, underside of head, propleura laterally, and appendages yellow.

In the female allotype the hemelytra are much reduced, reaching only to posterior margin of fifth abdominal segment, the posterolateral angles of the pronotum are not emarginate, and the color is lighter. The exposed dorsal surface of the abdomen yellowish, irregularly spotted with fuscous and the coria each with a yellow spot at middle of apical margin.

Size.—Male, length 7.75 millimeters, width (at level of embolium) 4; female, length 7.08, width (as above) 3.17.

Holotype, male, No. 4236, in the type collection of the California Academy of Sciences Entomology, Los Baños, July 17, 1936 (*R. L. Usinger*). Allotype, female, No. 4237, California Academy of Sciences Entomology, same data as type and thirteen paratypes from the same series. This species was fairly common in the swiftly flowing portions of Molawin Creek,

where the specimens were collected amidst the rocks and smaller pebbles.

In the series of paratypes there is an amazing variability in development of hemelytra, no two specimens being exactly alike in this respect. There is no evident sexual correlation in wing development in the series before me, both the longest and the shortest winged specimens being males. In the shortest winged example the hemelytra reach only onto the base of the third abdominal segment. The pronotum in this case is considerably less developed posteriorly and the whole insect is more feeble. There is likewise a great deal of color variation, the black spots of the head and pronotum being more extensive in some examples, while there is often more yellow on the hemelytra.

APHELOCHEIRINÆ

Kiritshenko (1929) has recently summarized the distribution of this interesting subfamily. Since that time another species, *Aphelocheirus bianchii* from Turkestan, has been added by the same writer, Esaki has described another Japanese species, and I (1937) have described a new species, *A. australicus*, from Queensland, this being the first member of the subfamily from Australia and a considerable extension of the known range of the genus. With the description of the two species in the present paper a conspicuous gap is closed in the map of Kiritshenko, and further additions are to be expected with further collecting in the Philippines and further south.

APHELOCHEIRUS UICHANCOI Usinger sp. nov. Plate 1, fig. 4.

Oval, more broadened behind than in front. Color in great part black with the head and appendages yellow. Connexival angles only moderately produced.

Head large, slightly broader, eyes included, than long, 28 : 25; longer than width of interocular space in front, 25 : 22; the ratio of posterior to anterior width of interocular space 15 : 22; disc moderately elevated, finely punctate, the anterior border rather evenly rounded, produced before the eyes twice as far as posterior portion is produced behind the eyes. Eyes almost three times as long as broad, 15 : 6, rounded posteriorly, scarcely laterally produced at anterolateral angles. Antennal segments 1 to 4 in the proportion 1 : 3 : 3 : 5. Labrum less than twice as broad as long, rounded apically. Rostrum reaching intermediate coxæ, the second segment over three times as long as

third. Gula moderately tumid. Pronotum over three and one-half times as broad as long on median line, two-thirds as long as head; disc elevated at middle, transversely rugose anteriorly and posteriorly, irregularly so elsewhere; anterolateral angles right angles, rounded at apices; sides moderately, evenly arcuate, the posterolateral angles narrowly rounded; posterior margin straight, broadly and only moderately prolonged posteriorly over bases of hemelytra. Scutellum over twice as broad as long, subbasally transversely depressed, slightly produced at apex. Hemelytra very abbreviated, not reaching posterior margin of first visible abdominal segment, subrounded at apices, more or less truncate on inner halves of posterior margins; lateral margins briefly sinuate basally, feebly reflexed, evenly rounded slightly beyond curve of base of abdomen, then abruptly angled and strongly sinuate behind. Connexival angles scarcely produced on first visible abdominal segment, progressively more strongly produced posteriorly, the margins feebly but distinctly notched and spined just before the posterior prolongations; elsewhere along the margins, except on first segment, irregularly, minutely spined, the spines usually seven. Venter rather strongly, roundly elevated at middle, segments 4, 5, and 6, each bearing a very inconspicuous cluster of from four to six spines on its posterior border at middle.

Male genital segments with apical side pieces as seen from above moderately long, narrowed posteriorly, and rounded at apices.

Female genital plates almost as long as broad at base; posterior margins sinuate laterally and basally, roundly angled at basal third and very broadly and strongly reflexed and truncate at middle forming a small emargination at apex.

Color black, the disc of head except at base, pronotum obscurely at center and along lateral margins, scutellum at center, narrow abdominal margins, under side of head and thorax, and rostrum and legs fulvous to testaceous. Spines and claws tawny. The male is brownish rather than black with the hemelytra testaceous along the emboliar and scutellar margins.

Size.—Male, length 10.66 millimeters; width (at greatest width of connexivum) 6.50; female, length 10.83; width (as above) 7.08.

Holotype, female, No. 4238, California Academy of Sciences Entomology, collected in Molawin Creek where it runs through the campus of the Agricultural College at Los Baños, July 17,

1936 (*R. L. Usinger*). Allotype, male, Molawin Creek, Los Baños, P. I., April, 1927 (*L. B. Uichanco*), in my collection. An additional female (same data as type) and an additional male (same data as allotype) are in the collection at the College of Agriculture, Los Baños. It is with great pleasure that I dedicate this species to its first collector, the enthusiastic and accomplished Philippine hemipterist Doctor Uichanco.

The holotype, one paratype and a nymph, were taken in swiftly flowing parts of the creek amidst rather large rocks. They were kept alive for a time in a small container of water, where they lay motionless as though dead, until, with a sudden effort, they would make their way to the surface. At no time was a silvery air film to be seen covering the under side of the abdomen, as is typical of the surface-breathing naucorids.

A. uichancoi is related to *A. inops* Horvath but is at once distinguished by its larger size, abruptly angular margins of wing pads behind embolia, nonemarginate posterolateral angles of pronotum with short, rounded posterior projections of posterior margin before bases of wing pads and somewhat larger projections of connexival angles, especially on the fourth and fifth segments. It resembles *kawamuræ* Matsumura, which, however, has the head more strongly produced before the eyes and the connexival angles much more strongly produced.

APHELOCHEIRUS PHILIPPINENSIS Usinger sp. nov. Plate 1, fig. 3.

Elongate-oval, fuscous to testaceous, pronotal margins and abdominal margins, except at base, minutely dentate, teeth rather evenly, widely spaced.

Head transverse, 25: 21, longer than anterior width of interocular space, 21: 17; ratio of posterior to anterior width of interocular space 10: 17; disc rather strongly elevated, finely rugose, with punctures basally and laterally; produced only twice as far before the eyes as behind the eyes; anterior margin rounded more strongly toward the sides. Eyes twice as long as broad, inner margins moderately rounded, outer margins more strongly so, anterolateral angles feebly, lamellately produced. Rostrum attaining middle coxæ, the second segment over three times as long as third, 24: 7. Labrum twice as broad as long, rounded apically. Proportion of antennal segments 1 to 4 as 1.5: 6: 5: 8.5. Gula only slightly tumid. Pronotum strongly transverse, almost four times as broad, posteriorly, as long on median line, 51: 14; two-thirds as long as head on median line; transversely rugose, especially anteriorly and posteriorly

at middle, elsewhere finely punctate; anterolateral angles little more than right angles, subrounded; sides moderately, evenly arcuate with twelve minute, evenly spaced teeth on dorsal edge; posterolateral angles subangular, rounded at apices; posterior margin scarcely arcuate, with short rounded projections at bases of wing pads. Scutellum strongly transverse, almost three times as broad as long, 29: 11, transversely depressed at base. Hemelytra not reaching posterior margin of first visible abdominal segment, rounded apically; emboliar margin sinuate and reflexed basally, thence strongly, roundly dilated, behind which it is subangulately truncate; margin behind this rather strongly sinuate. Abdominal margins except on basal segment with about six minute, evenly spaced spines per segment; posterolateral angles of segments little more than right angles except on last two segments which are bluntly produced in the female. Abdomen beneath strongly, roundly elevated at middle, especially posteriorly, the fourth, fifth, and sixth segments bearing from four to six spines, transversely arranged near posterior margins at middle.

Male genital segments with apical side pieces visible from above long and slender, slightly exceeding tip of genital capsule, evenly narrowed posteriorly and rounded at apices.

Female genital plates almost as long as broad at base, the posterior margins subangular at basal third, abruptly angular on either side, near apex forming a small, triangular emargination at middle.

Color fuscous to black, the pronotum laterally, scutellum, hemelytra except submarginally, narrow connexival margins, genital segments, and under side in great part fulvous to testaceous. Ventral surface laterally glaucous to lurid. Rostrum and spines of legs and abdomen fulvous. Female with interocular space laterally and under side of head testaceous.

Size.—Male, length 7.92 millimeters; width (at greatest width of connexivum) 4.92; female, length 8.75; width (as above) 5.25.

Holotype, male, No. 4239, California Academy of Sciences Entomology, taken in Molawin Creek on the slopes of Mount Maquiling just beyond the mud spring, July 19, 1936 (*R. L. Usinger*). Allotype, female, same locality as type, July 18, 1936, in my collection. Both of these specimens and a single nymph were found after a diligent search in the swiftest part of the stream.

This species is doubtless very closely allied to *Aphelocheirus uichancoi;* but it is superficially very different and may be distinguished at once by its smaller, more slender form, lighter color, hemelytral and connexival margins, and genitalia. It is likewise allied to *A. inops* Horvath but has the posterior margin of the pronotum angulately emarginate near lateral angles. The lateral margins of embolia are not sinuate on basal third in *A. inops,* the female genital lobes are rounded laterally and do not form a small emargination at apex, and the male lobes do not reach the level of the apex of the genital capsule.

LITERATURE CITED

KIRITSHENKO, A. N. Compt. Rend. Acad. Sci. de l'URSS (1929) 12.
LETHIERRY, L. Bull. Soc. Ent. France 101 (1877).
LUNDBLAD, O. Archiv für Hydrobiol. Supp. 12 (1933) 64, fig. 19.
MONTANDON, A. L. Bull. Mus. Hist. Nat. 3 (1897) 125.
STÅL, C. Öfv. Vet.-Akad. Förh. 11 (1854) 239.
STÅL, C. Enum. Hemipt. 5 (1876) 145.
USINGER, R. L. Australian Zoöl. 8 pt. 4 (1937) 341.

ILLUSTRATIONS

PLATE 1

FIG. 1. *Asthenocoris luzonensis* sp. nov., dorsal view of male.

2. *Asthenocoris luzonensis* sp. nov., ventral view of male.

3. *Aphelocheirus philippinensis* sp. nov., dorsal view of female and terminal abdominal segments of male.

4. *Aphelocheirus uichancoi* sp. nov., dorsal view of female and terminal abdominal segments of male.

TEXT FIGURES

FIG. 1. *Naucoris obscuripennis* Stål, male genitalia. *a*, Genital capsule, dorsal view; *b*, left paramere; *c*, right paramere.

2. *Asthenocoris luzonensis* sp. nov., male genitalia. *a*, Genital capsule, dorsal view; *b*, left paramere; *c*, right paramere.

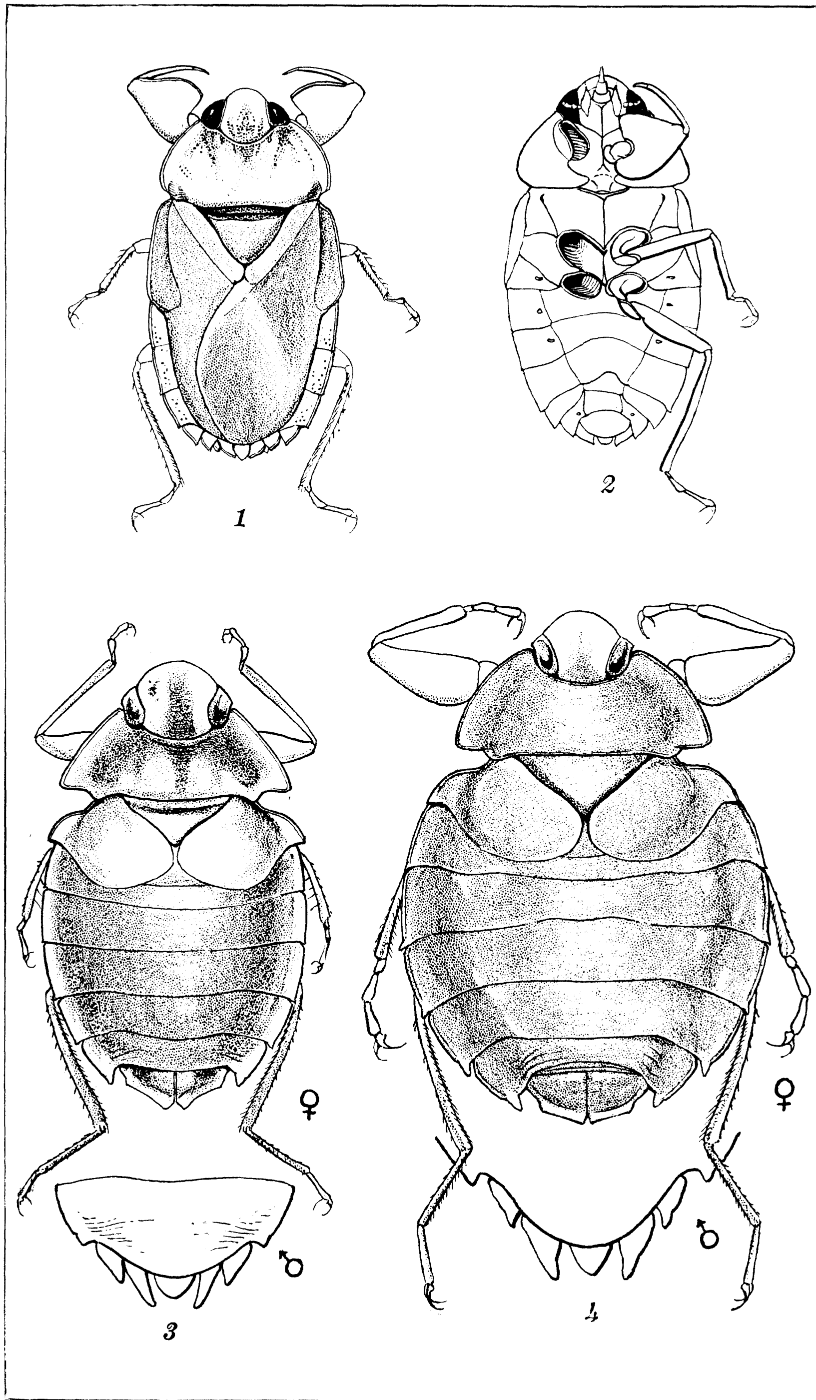

PLATE 1.

THE REMONTADOS OF RIZAL PROVINCE [1]

By Generoso S. Maceda
Of the National Museum Division, Bureau of Science, Manila

FOUR PLATES

Of all the pagan groups of the Philippine Islands, the Remontados, otherwise known as the Pagan Tagalogs, are the most peace-loving, although they are the descendants of the outlaws of Christian towns, who fled to the mountains to evade payment of taxes during the Spanish regime. Unlike other pagan groups, they have abandoned their lawless life and have become useful citizens. Kindness, friendliness, and trustworthiness characterize their dealings with both mountaineers and lowlanders.

At present the Remontados dwell chiefly in the eastern part of Rizal Province, particularly in the barrios of Sta. Ines, Antipolo municipality; Tinukan, Mamuyao, San Andres, Cuyambay, Layban, Daraitan, and Sampaloc, Tanay municipality; and Macabod, Anginan, Cabooan, Mabolo, Malasia, and Puray, Montalban municipality. Table 1 shows their distribution.

Table 1.—*The distribution of the Remontados in Rizal Province.*[a]

Barrio.	Municipality	Male.	Female.	Total.
Santa Ines	Antipolo	185	143	328
Cuyambay	Tanay	140	153	293
San Andres	do	76	73	149
Tinukan	do	73	72	145
Mamuyao	do	115	111	226
Layban	do	135	231	366
Daraitan	do	129	139	268
Sampaloc	do	153	120	273
Macabod	Montalban	99	67	166
Anginan	do	44	39	83
Mabolo	do	45	42	87
Malasia	do	28	26	54
Cabooan	do	30	35	65
Puray	do	79	68	147
Total		1,331	1,319	2,650

[a] Prepared under the direction of Mr. Claro Samonte, superintendent of the Remontados of Rizal Province, as of December 19, 1936.

[1] The writer wishes to express his sincere appreciation of the coöperation given by Mr. Claro Samonte, superintendent of the Remontados, and his assistant, Mr. Perfecto Villamor, in the preparation of this manuscript.

Although the Remontados are generally inclined to a seminomadic life, steady invasion on the part of the lowlanders forces them to permanent settlement in and around their clearings; otherwise, their kaiñgins would be absorbed by the invaders.

"Remontados" is derived from the Spanish verb *remontar;* meaning "to frighten away." Many of the people now designated by this term are the descendants of former townspeople who left their towns and fled to the mountains to live as outlaws, rather than to pay tribute to the Spanish government, and because they had little liking for so-called civilized life. Beyer says of this group "Most writers have casually dismissed them as descendants of remontados, or outlaws from the Christian towns, who have fled to the hills and there mixed with wandering bands of Negritos." [2] Sawyer adds: "The tendency of the Philippine native to revert to old customs is well marked, and I agree with Jagor when he says: 'Every Indian has an inmate inclination to abandon the hamlets and retire into the solitude of the woods, or live isolated in the midst of his own fields,' in fact to *remontar.*" [3]

Physical characteristics.—The Remontados are of mixed blood. Their physical characteristics show two distinct influences, Dumagat and Tagalog. According to Prof. H. O. Beyer they are predominantly of the short Mongol physical type, mixed with Negrito and lowland Filipinos of the vicinity.[4]

Generally they have well-developed extremities by reason of their industrious everyday life.

Ornaments and bodily decoration.—The Remontados are very fond of adornment, and readily spend their savings for this purpose. On special occasions, like fiestas and marriage feasts, they dress in their beautiful costumes and display their bejuco rings decorated with orchids, seeds, fruits, and rare forests flowers, to win the admiration of the opposite sex.

Tattooing is practiced by the Remontados, who call this practice *cadlet.* A pointed piece of metal is used in the process, and powdered charcoal serves as pigment.

They also grind the incisal edge and the anterior surface of their front upper teeth in order to give them uniformity in length and a concave appearance.

[2] Population of the Philippines in 1916, Manila (1917) 60, 61.

[3] The Inhabitants of the Philippines (1900) 210.

[4] Population of the Philippines in 1916, Manila (1917) 61.

Language.—The Remontados speak a language that is purely Tagalog, although intonational differences may be observed among the different groups. The differences may be attributed to intermarriage with both the Dumagats and the lowland Tagalogs.

Political life.—The Remontados, like their Christian neighbors, have a definite and established form of political organization, the officers of which are the president, the vice president, the councilors, the secretary, the chief of police, and the members of the police force. All these officers are elected by open vote, supervised by the superintendent. Each barrio elects its own officers, whose duties are merely to pass ordinances pertaining to the public works of the barrio concerned. Much of the life of the Remontados is regulated by old customs and traditions, which are closely observed and seldom violated.

Food.—The staple food of the Remontados is rice, supplemented with root crops, corn, bananas, and papayas, which are all grown in the kaiñgins of the group. Remontados have a peculiar method of cooking rice, called *binoho;* that is, boiling the rice in bamboo tubes. Other foods of the Remontados are the flesh of various forest animals; such as monkeys, deer, wild hogs, and chickens; and river fishes, such as eels, mudfishes, and shrimp (*sugpo*).

Their methods of catching wild hogs and monkeys are interesting. For the former they use the *balaes,* and for the latter, the *pakuis.* The balaes is a trap set on the ground where the trails of the wild pigs are. It consists of a long wooden pole bent into a bow, one end of which is provided with a piece of *caña boho* to serve as the point of an arrow. The other end of the pole is fastened on two pieces of wood driven into the ground two feet apart. These two pieces of wood are the main holders of the formed bow. A hook holds the end of the bow where the arrow is attached, and a piece of vine is tied on the hook. The length of the vine depends upon the radial reach of the bow, one end of which is provided with the decoy, usually cassava roots. When the wild boar eats the decoy, the hook jerks and suddenly releases the bow. The arrow is thrust into the wild boar's trunk by the flexible force of the bow. Usually the animal is not instantaneously killed, but merely weakened, so that little chasing ends the game.

The *pakuis* is a snare set up on the ground to trap monkeys. It consists of a post about two meters high driven into the ground. Another piece of wood is tied on top of the post in an inclined position. A rattan loop is formed at the upper end of the inclined piece of wood. In front of the loop the decoy, usually fruits, is provided to attract the hungry monkeys. Below this setting, a heavy log is suspended, connected with the formed loop. The suspended log forming the lower part of the apparatus is thickly covered with rattan spines, so as not to give way to the animal except towards the loop. As soon as the animal picks up the decoy, the suspended log drops down and the loop strangles the victim against the inclined log.

Eels and mudfishes are also caught in a peculiar manner; namely, by means of the implements composing the catapult, the dart, and the goggles. The chaser dives into the water with the apparatus, locates the holes where the fishes are hiding, and then thrusts the dart into the holes.

Housing.—There are three distinct types of houses, as shown in Plate 1, figs. 2 to 4. The materials used in the construction are: Tree trunks, caña boho, rattan, and cogon grass. Usually, the houses are very low. When cogon grass is not available, divided caña boho is used for the roof and along the sides. The house is usually entered by means of detachable ladders which are removed when the family is away, to keep out animals.

Fire making.—The Remontados have two primitive methods of producing fire, the firesaw and the *pinkian* (flint and steel). The firesaw method involves the rubbing of the edge of split bamboo over another piece in a horizontal position. Bamboo shavings are placed between, and rubbing continues until the shavings combust by friction. Ignited shavings are then blown into a flame. The pinkian is an ensemble of flint, steel, and *akipan,* fine dried husk of palm trees which burns readily. The steel is struck against the flint and the resulting sparks igniting the akipan are blown into a flame.

Industries.—The Remontados have very few industries. They have no knowledge of pottery. A little mat, hat, and basket weaving is done. Agriculture is carried on according to the kaiñgin system. Trade with the lowlanders in rattan, vines, almaciga, and other forest products is also a source of income to them.

Family life.—The Remontados are monogamous. The discovery of adultery, which very seldom happens, results in the

separation of the husband and wife. The dowry and all the marriage expenses of the couple are returned by the offending party to the offended, but if this is not accomplished, the alternative is the death of the guilty party.

Marriage.—Marriage, called *pagbabalae,* is performed by parental arrangement. The families of the boy and the girl make the contract of marriage when the children are still quite young. When the boy and the girl reach puberty, the parents of the girl ask of the young man's parent a certain amount of money, ranging from 10 pesos to 100 pesos. This sum is locally termed *bilang,* or dowry. Aside from the dowry the girl is provided with clothes, and her parents with rice and working animals. The last that the parents of the boy provide is the house where the couple is to live permanently.

On the day of marriage the bride dresses in the house of one of her nearest relatives. The bridegroom then fetches her and they walk along the street to the bride's house. The relatives of the bride kneel on the street as the couple passes by and beg from them rice and wine. When they reach the house, an old man performs the marriage ceremony and counsels the couple loudly in the following words:

"Kayong mga anak ay kaawawa at kayo ay mahihiwalay na upang mamahay na ng sarile. Huag na ninyong uugaliin ang pagkabata, kung hindi parang sa matanda na at kung dumarating ang inyong mga magulang ay inyong pakakanin at pañgañgañgain." (I pity you children, you are separating from your parents to live independently. Do not be childish anymore but behave like the old folks and when both your parents visit you, offer them food and buyo.)

After that counsel the couple is considered married.

The poor Remontados do not adhere to these marriage rites. The poor man and woman, after obtaining parental consent, live together as husband and wife.

Children.—Customarily the child is born in the home of its parents. The mother gives birth in a squatting position. The midwife who take charge of the delivery is usually an old woman, assisted by the husband. The husband is always present, because it is believed that if he is absent the wife will encounter hardships in the delivery of the child.

Amusements.—Dancing the *fandango* is an indispensable part of every feast among the Remontados. Love *kundimans* are sung to the guitar. The Remontados are very fond of music,

so that even at work or while walking they cannot help but sing. The songs that they sing are locally known as *ilda*. Some of the beautiful passages of the *ilda* in rhyme are here quoted:

"Ako ay paalam malantik na ñgipin, sa iyo naman vivo kung tumingin." (As he bids goodbye to the lady with concave teeth, the man look at her vividly.)

"Kung ako ay titigan ng maamo mong mata, daig ang salapi at badlang gayuma." (I do not listen to money and charms when you look at me with your wistful eyes.)

Sickness and cure.—Unlike other groups of mountain people, the Remontados regard their diseases as physical in nature. They do not believe that sickness is caused by certain evil spirits whom they have unintentionally offended. To cure their ailments, they resort to many kinds of roots, leaves, and fruits of plants.

Skin disease, called *buni*, is very common. Malaria, and enlargement of the neck and the stomach, are other diseases prevailing in their community.

Death and burial.—The Remontados believe that when a person dies his spirit will return. *Bibit* is the local term for the spirit of the dead. They further believe in a life hereafter.

If a person dies, he is buried in the very place where he expired. There is no cemetery provided for the dead. The house inhabited by the deceased is burned, for it is believed that his spirit will return to it.

The burial ceremony is short and simple. It is performed by an elder man who recites the following:

Iiwan namin ang sigala at lalamnan ng iyong ngangangain at ikukuha ka namin ng pagkain mo pagkat hindi ka na makakain ng pagkain natin dahil sa ikao ay namatay na. Sayang ka naman at hindi mo na makakain ang iyong pinag paguran at ikao ay pagtatapusan namin sa mga lingong arao. Kami ay aalis na dito sa iyong kinamatyan at aming susunugin pagkat kami ay bibibiten. (We are leaving the wallet with buyo and we will provide you with food because you will not be able to eat your share with us and by next week we will celebrate the ninth night of prayer for you. We will destroy our house otherwise your spirit may visit us.)

Then all persons present at the ceremony sing the song for the dead called *dalet*. This dalet is repeatedly sung for nine nights successively.

Liko liko ka man sapa dati kitang binabanka, doon dao ay may lanka matamis dao pati sutla.

Langit langit na maitim ibababa ka na namin at sa Dios iaalay namin upang sa pagkakasala'y patawarin.

(You will pass a meandering stream and you will reach the place where sterile carpels of jackfruits are also sweet. Clowdy sky, we are lowering the deceased and we will pray God to pardon him for his sins.)

The relatives of the deceased visit the resting place, bringing food and other offerings on the third day. To know if the spirit of the dead visited the house where the nine nights of prayer were held, they spread ashes on a winnowing tray at the entrance of the house. This is done on the fourth night after the interment. The following morning the tray is examined, and if the surface of the layer of ashes seems disturbed, it is said that the spirit had returned in the night. As a matter of fact the disturbance may have been caused by domestic animals roaming about the house at night.

ILLUSTRATIONS

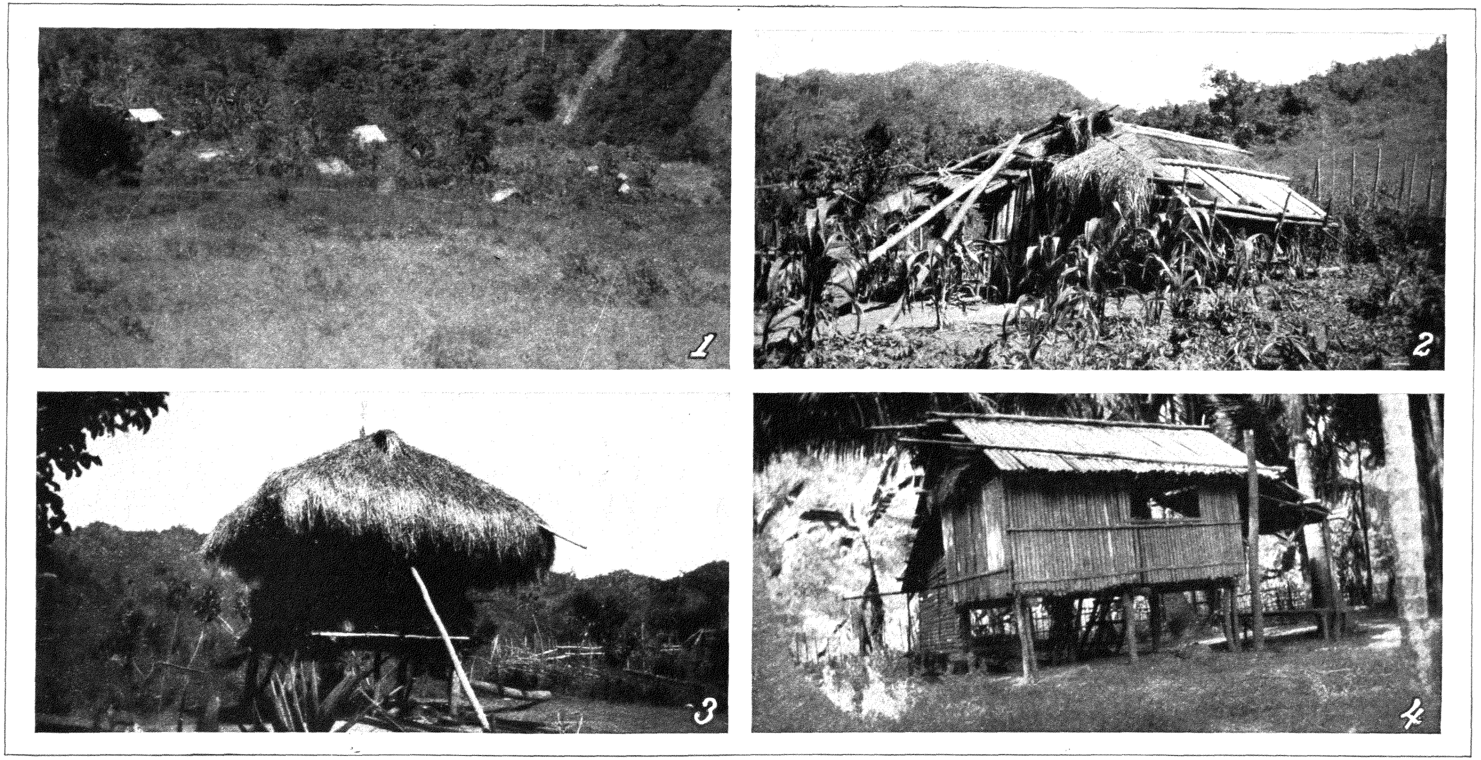

PLATE 1.

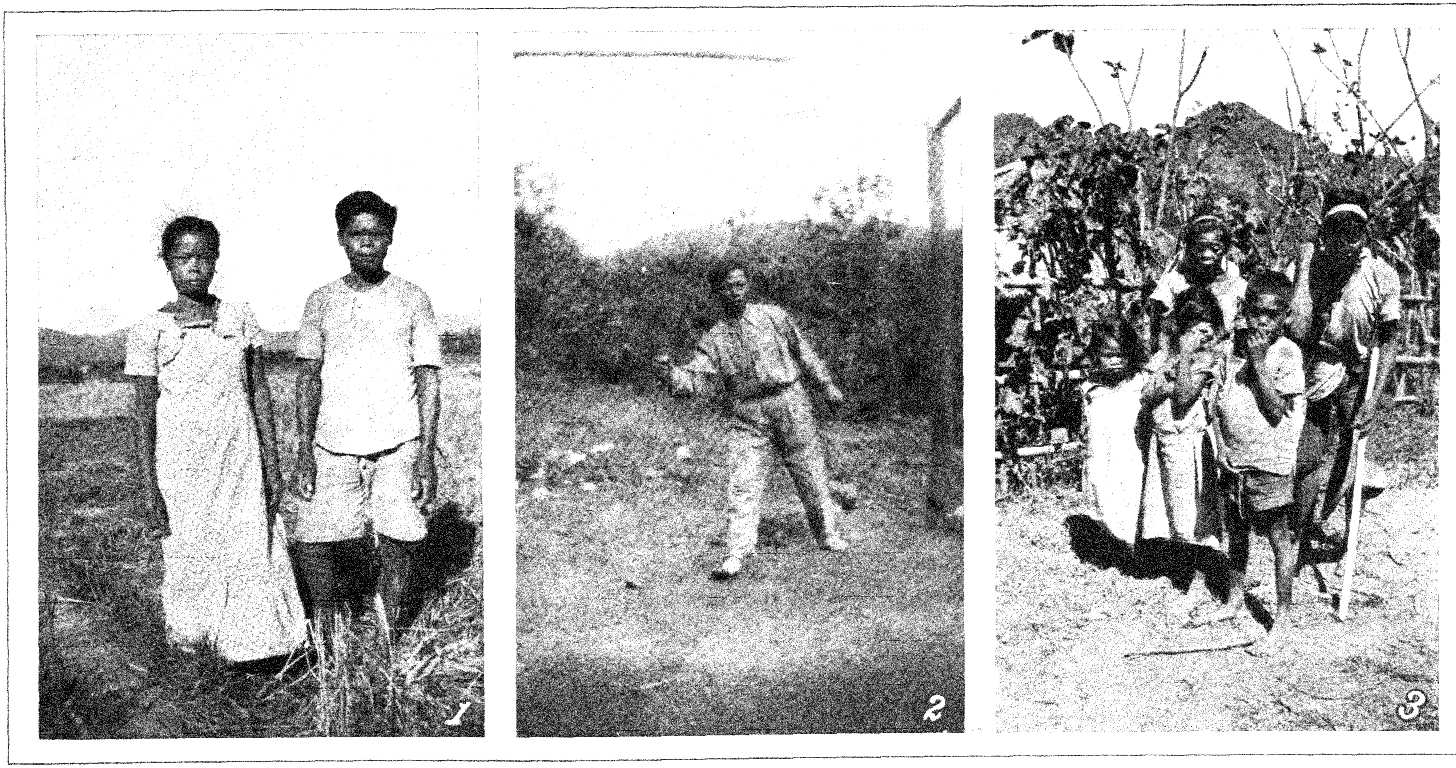

PLATE 2.

PLATE 3.

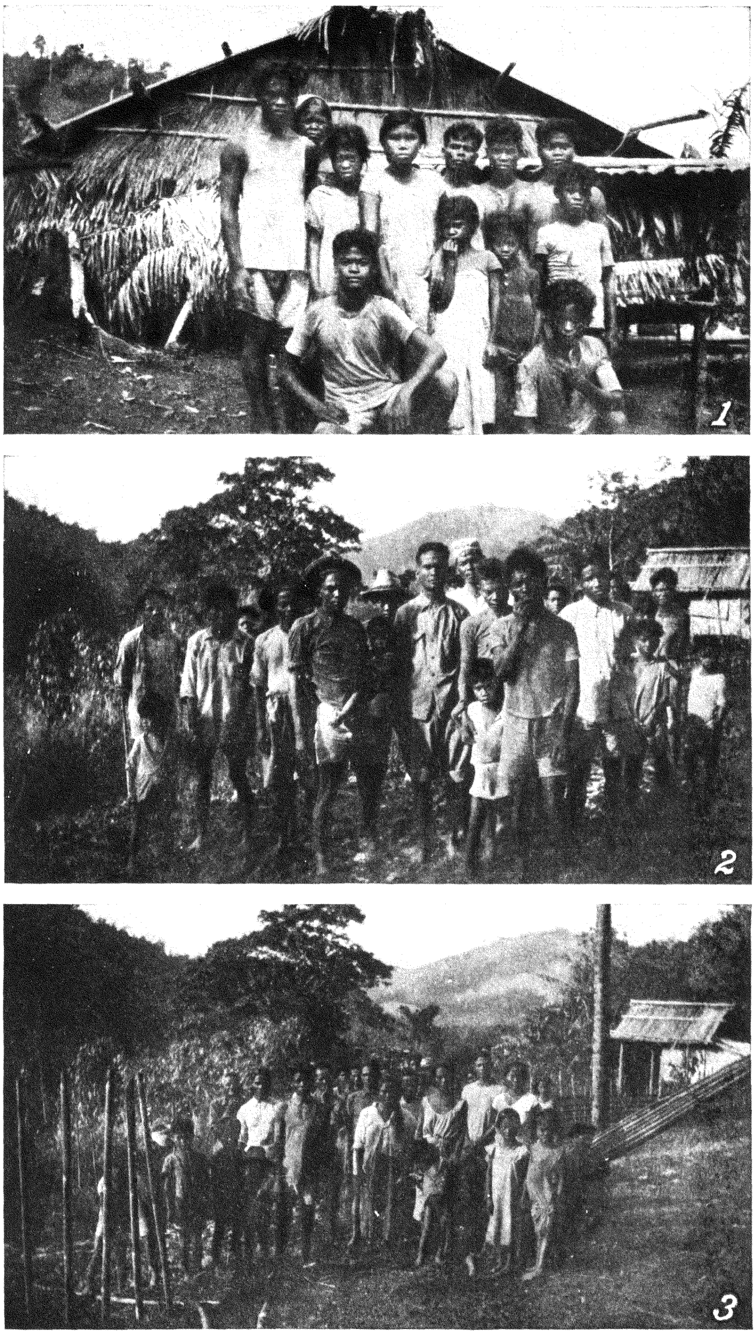

PLATE 4.

BOOKS

Acknowledgment of all books received by the Philippine Journal of Science will be made in this column, from which a selection will be made for review.

RECEIVED

American Institute of mining and metallurgical engineers. Petroleum division. Transactions, vol. 123. Petroleum development and technology, 1937. New York, The Institute, 1937. 689 pp., illus., tables. Price, $5.

CHALMERS, LEONA W. The intimate side of a woman's life. Foreword by W. S. Pugh. Radio City, New York, Pioneer publications, Inc. 1937. 128 pp., illus. Price, $1.50.

DAVIS, ROBERT H. Deep diving and submarine operations; a manual for deep sea divers and compressed air workers. London, The Saint Catherine press, 1937. 510 pp., illus., photographs. Price, 18s.

FROIN, G. Pression solaire. Faisceau énergétigue et biologie biogenése et pathogenése. Paris, Librairie Girardot et Cie, 1937. 327 pp., illus. Price, 30 frs.

HACKETT, LEWIS WENDELL. Malaria in Europe; an ecological study. London, Oxford University press, 1937. 336 pp. Price, $3.75.

HISCOX, GARDNER DEXTER. Henley's twentieth century book of formulas, processes and trade secrets; a valuable reference book for the home, factory, office, laboratory and the workshop; containing ten thousand selected household, workshop and scientific formulas, trade secrets, chemical recipes, processes and money saving ideas for both the amateur and professional worker; revised and enlarged edition by T. O'Conor Sloane. New York, Norman W. Henley publishing company, 1937. 833 pp., illus. Price, $4.

JOYEUX, CH., and A. SICÉ. Précis de médecine coloniale. 2d ed. Paris, Masson et Cie, 1937. 1250 pp. Price, 170 frs.

MANSFIELD, WILLIAM. Materia medica, toxicology and pharmacognosy. St. Louis, The C. V. Mosby Company, 1937. 707 pp., illus. Price, $6.75.

MONRO, C. C. A. Polychaeta. The John Murray expedition, 1933–34, Scientific reports, vol. 4, no. 8. London, The British Museum (Natural History), 1937. pp. 243–321, illus. Price, 5s.

MORRISON, A. CRESSY. Man in a chemical world; the service of chemical industry. New York, Charles Schribners' sons, 1937. 292 pp. Gratis.

NEEDHAM, JAMES G., and others. Culture methods for invertebrate animals. A compendium prepared coöperatively by American zoölogists under the direction of a committee from Section F of the American Association for the Advancement of Science. Ithaca, Comstock publishing company, 1937. 590 pp., illus. Price, $4.

OTTER, G. W. Rock-destroying organisms in relation to coral reefs. Great Barrier Reef Expedition, 1928–29, Scientific reports, vol. 1, no. 12. London, British Museum (Natural History), 1937. pp. 323–352, plates, illus. Price, 5s.

PAGÉ, VICTOR WILFRED. Ford V 8 cars and trucks; construction—operation—repair; a most complete and practical manual explaining the construction of all parts of late model Ford automobiles with instructions for driving, servicing and repairing; written in simple language; a universal book of reference; illustrated by many specially made diagrams and distinctive original photographs of actual parts furnished by the factory service department. New York, Norman W. Henley publishing company, 1937. 729 pp., illus. Price, $2.50.

POPPE, THOMAS WILLIAM, and H. P. STRAND. House wiring; a treatise; describing and illustrating up-to-date methods of installing electric light wiring, bell and telephone wiring and burglar alarm wiring; intended for the electrician, helper and apprentice, fully illustrated by 191 original engravings. 8th ed. rev. and enl. New York, Norman W. Henley publishing company, 1937. 256 pp., illus. Price, $1.

SHEPHARD, C. Y. The Cacao industry of Trinidad; some economic aspects. Series II–IV. Trinidad, Government printing office, 1936. 2 vols. Copies of these publications may be obtained on application to the Editor, "Tropical Agriculture," Imperial College of Tropical Agriculture, Trinidad, B. W. I. Price, 7s.

SWEETMAN, HARVEY L. The biological control of insects; with a chapter on weed control. With a foreword by L. O. Howard. Ithaca, Comstock publishing company, Inc., 1936. 461 pp., illus. Price, $3.75.

United fruit company. Research Department. Nutritive and therapeutic values of the banana; a digest of scientific literature. Boston, United fruit company, 1936. 143 pp. Gratis.

REVIEWS

Adolescence; A Study in the Teen Years. By Lawrence Augustus Averill. Boston, Houghton Mifflin Company, 1936. 496 pp. Price, $2.25.

As one of the most recent, it undoubtedly is the most interestingly written of the books dealing with that most revolutionary period of life, adolescence. The book is different from most textbooks on the subject in that the author "has paid little attention to theories" but has instead, according to the author's preface, "endeavored rather to present the adolescent individual as a living, striving, flesh-and-blood person whose growth and development are in considerable measure determined by the nature of the parental, social, and community influences that surround him."

The author presents in case studies adolescent behavior and conduct. This makes the book interesting reading from beginning to end. The book is recommended to all who deal with adolescents, whether at home, at school, or in the community.

Parents especially should find this book not only delightful reading but also instructive in problems dealing with their children's behavior.

This book has fourteen chapters. Some of the chapters that should be of interest to every one are: Crime and Delinquency; The Parent and the Adolescent; The School and the Adolescent; The Role of Sex in Adolescence; The Adolescent's Religion.

—S. G. P.

Applied Soil Mechanics. By William S. Housel. University of Michigan, Civil Engineering Department, 1933. 94 pp., illus., plates. Mimeographed. Price, bds. $4.40.

A comprehensive treaty on applied soil mechanics, useful to the highway and construction engineers in general and agricultural engineers in particular. The historical development of the subject is well discussed in the first chapter.

In a lengthy discussion the author makes a very clear exposition of the subject on pressure distribution with well-selected analogy. The theory of soil resistance and methods of measurement covers the rest of the book. The book is furnished with illuminating illustrations, tables, and diagrams.—D. Z. R.

Asia Directory; A Complete and Up-to-date Guide to the Principal Manufacturers, Exporters, Importers, Merchants, Shipping and Insurance Companies, Banks, Commercial and Governmental Organizations, etc. in the Japanese Empire, British India, Burma, Ceylon, China, the Dutch East Indies, French Indo-China, Hawaiian Islands, Hongkong, Kwantung, Territory, Manchoukuo, Philippine Islands, Siam, Straits Settlements; Classified according to Commodities and Trades, and Arranged Alphabetically for Rapid Reference. 1936–37 Edition. Yokohama, Japan, The Asia Directory Publishing Company. Price, Y15.

The editor of the Asia Directory says in his preface that he has endeavored not only to fulfill the need for a genuinely up-to-date and comprehensive business directory but "also to provide a link between potential buyers and sellers, so that they may get into direct touch with one another." In order to check up personally the entries in the Directory, Mr. R. Mori, the editor, travelled extensively in all the countries dealt with, except North China and Manchoukuo.

This directory is of particular value only to those interested in Japanese products, as it deals with manufacturers, exporters, and merchants in 22 important cities in Japan. The Directory covers the Japanese Empire more extensively than the other countries. More than half of the whole volume is devoted to the Japanese Empire alone.

The indices given are; Index to Towns; Index to Countries, Towns, etc.; Index to Names of Advertisers; and Index to Trade Headings for the Japanese Empire only. The page numbers do not run consecutively throughout the book, each country being given new pagination.

The book should be in the office of every commercial firm importing Japanese products. Exporters and importers will find it a good source of information in establishing trade relations with Japan and other oriental countries.—P. S. S.

Disability Evaluation; Principles of Treatment of Compensable Injuries. By Earl D. McBride. Philadelphia, J. B. Lippincott Company, 1936. 623 pp., illus., tables, diagrs. Price, $8.

This is a reference book of extraordinary exhaustiveness. It contains careful description of the most common injuries and disabilities following industrial accidents, and also extended discussion and practical consideration of the ways of appraisal or evaluation of these disabilities. The description of the suggested treatment and methods of rehabilitation is clear and logical. This books should be in the library of every practicing surgeon. —J. I. A.

Experimental Studies on a Transmissible Myelomatosis (Reticulosis) in Mice. By Otto Kaalund-Jørgensen. Acta Radiologica, Supp. XXIX. Copenhagen, Levin & Munksgaard, 1936. 142 pp., plates, tables. Price, Swedish cr. 12.

This monograph gives the results of an experimental investigation on the nature, histology, and mode of propagation of a transmissible myelomatosis in mice. The disease is compared with the filterable fowl leukoses, the transplantable mammalian tumors, the transmissible leukoses, and the human leukoses. Among the important findings recorded is that the mouse myelomatosis differs from the leukoses of fowls by its nontransmissibility by a cell-free agent. In this respect it resembles the mammalian tumors, but differs from them in being a systemic generalized disease which cannot be transmitted by intravenous inoculation.—M. T.

Factor Table, Giving the Complete Decomposition of All Numbers Less than 100,000. Prepared Independently by J. Peters, A. Lodge, E. J. Ternouth and E. Gifford, and Collated by the British Association Committee for the Calculation of Mathematical Tables. (British Association for the Advancement of Science. Mathematical Tables, vol. 5). London, Office of the British Association, 1935. 291 pp., tables. Price, 20s.

A factor table is of great value to those engaged in mathematical calculations. A glance at these tables of the British Association for the Advancement of Science reveals painstaking and laborious effort in producing this very handy and valuable table for mathematicians.—J. C. E.

Farm Organization and Management. By G. W. Forster. Ann Arbor, Michigan, Edwards Brothers, Inc., 1935. 210 pp. tables, illus. Price, $3.

The author, G. W. Forster, Agricultural Economist, North Carolina State College of Agriculture, University of North Carolina, has had actual farm experiences in several parts of Canada and the United States, and also 15 years of teaching and research experience. In this book he has integrated the general economic principles as they apply to farm management and sound farm practices, making it very satisfactory for teaching purposes. It is divided into two parts—the first part dealing with the organization of the farm and the second part with its management. Types of farming and farm records have been omitted in the text to give way to those subjects which deal primarily with the organization and management of individual farms.

The most important feature of the book is that the author always supports his ideas with either tabulated or graphical illustrations, and every chapter is followed by a set of questions which are very helpful to a ready understanding of the subject. To teachers and students of agricultural economics, farm managers and administrators, agricultural leaders, and those actively engaged in similar undertakings, Farm Organization and Management is a valuable book.—H. S. S.

German Agricultural Policy, 1918–1934. The development of a National Philosophy Toward Agriculture in Postwar Germany. By John Bradshaw Holt. Chapel Hill, The University of North Carolina Press, 1936. 240 pp., maps. Price, $2.50.

This book is a comprehensive presentation of Germany's agricultural policy during the postwar period, from 1918 to 1934. It was presented as a dissertation for the degree of doctor of philosophy at the University of Heidelberg, Germany. It is composed of four parts.

The first part discussed the farm policy of a socialistic, economic-political group—the Social Democrats. Legislative measures were enacted between 1918 and 1920, defining the farm

policy of the Social Democratic Party, which emerged from the Council of People's Commissars of the Revolution, as it was consistent with its desire to socialize and democratize both labor and capital for the benefit of the consumers.

Part 2 deals with the return to liberalism. The consumers demanded cheap foodstuffs and low taxes, while the producers strove for high prices. On account of the changed composition of the Reichstag, where the producers had the upper hand, the government abolished the food administration in 1923 and approved measures for low taxes.

Industrial control, federalization, and the Farm Revolt are the subjects treated in the third part. Continuing the enforcement of the Land Settlement Act there was effected a big redistribution of lands, so that from 1919 to 1932 about 4 per cent of the estates in the northern provinces were redistributed in the form of small family subsistence farms. The Government agricultural price policy became more complicated, as it had to deal with such difficult phases as farm credit, protective tariff, and control of food consumption.

The last part presents the rule of National Socialism in regard to agriculture. In 1933 the National Socialism Party came into power. In accordance with the Party's 1930 program, the Government gave the farmers absolute protection against any threat of depression. The export industry of Germany was sacrificed to protect the domestic farm prices. In fact, the policy adopted was of a national-racial character; and the party in power was ready to decide on all questions involving not only economic, but also social and political as well.

The book is very instructive and should be read by all those concerned with the formulation of Government agricultural policies.—H. S. S.

Individual Psychology: Theory and Practice. By C. M. Bevan-Brown, G. E. S. Ward, and F. G. Crookshank. London, The C. W. Daniel Company, Ltd., 1936. 79 pp. Price, paper, 2s 6d.

The pamphlet contains a series of articles on the theory and practice of individual psychology. The first article, by Dr. C. M. Bevan-Brown, Chairman of the Medical Society of Individual Psychology of London, is really his presidential address. It is a plea for correlation of the various schools of psychoanalysis of Freud, Jung, and Adler.

The second article, "Heart and Mind," by Dr. G. E. S. Ward, a cardiologist, discusses the 'supreme importance of the state of mind of the patients' when dealing with cardiac cases.

The reader who is not acquainted with psychological literature will wonder what individual psychology is. This series of articles will give the reader some idea of this school of psychology, founded by the late Dr. Alfred Adler, the internationally known physician and psychologist.—S. G. P.

Land Settlement; A Report Prepared for the Carnegie United Kingdom Trustees. By A. W. Menzies-Kitchin. With a Foreword by the Trustees. Edinburgh, T. and A. Constable, Ltd., 1935. 175 pp., tables. Gratis.

This book presents an exhaustive study of land settlement problems in Great Britain. It was the assigned task of the author to suggest plans for a new land settlement program. In the preparation of his report to the Carnegie United Kingdom Trustees, Mr. Kitchin gathered an immense amount of information in the course of his trips to many parts of England and Scotland, supplemented by data obtained while making personal visits to certain sections of three leading countries in Continental Europe. In this particular field of economics, Mr. Kitchin's work can hardly be excelled in thoroughness of treatment and in carefully reasoned arguments that led him to draw the conclusions he did. The reader should examine the report and the "foreword" by Mr. Elgin representing the trustees, contained in the same volume. It will be seen that while the trustees differed from Mr. Kitchin on one vital point—the size of holding most appropriate for settlement—it would be conceded that the author was justified in making the deduction strictly from the economist's viewpoint. Upon a broad consideration of the various questions involved, the author finally arrived at a few specific conclusions, of which the proper size of holding for the unemployed laborer is of utmost importance.—H. S. S.

Modern Views of Atomic Structure. By Dr. Karl Rast. Translated from the German by Dr. W. O. Kermack. London, Frederick Muller, 1935. 156 pp., illus. Price, 7s 6d.

As stated in the translator's preface, this book gives an account, in nonmathematical language, of the advances which have been made in recent years in the domain of atomic theory, with special reference to that problem which is of fundamental

importance to the chemist, namely, the essential nature of the periodic system of the elements. Some of the more important advances that have been made since the original German text was published are also included.

Various topics, such as Avogadro's number, the structural units of the atom, quantum theory and numbers, periodic system, X-Ray spectra and electro-magnetic mass are discussed and explained in a most interesting and popular style.—A. P. W.

An Outline of Malayan Agriculture. Compiled by D. H. Grist. (Malayan Planting Manual No. 2) Published by the Dept. of Agriculture, Straits Settlements and Federated Malay States, Kuala Lumpur, 1936. 377 pp., illus., maps, plates. Price, $3.

In the treatment of the agricultural conditions of Malaya, the author has a complete view of the development of the geographical conditions, climate, geology and soils, and also the development of politics, communications, populations, and agricultural industries. Treatises on land tenure, agricultural policy, agricultural population and Malayan agricultural service, are complete, although not in detail, and contain the most essential and fundamental facts needed by students of the subject. In the second chapter, where methods of cultivation and soil treatment are emphasized, the tools and their use for each individual crop or plant are described in detail. In the third, each major crop of Malaya such as rubber, coconuts, rice, oil palms and pineapples, is treated separately. How these plants are treated in Malaya, including income which is the most important part of any commercial undertaking, is discussed in this chapter in detail for the information of all.—M. B. R.

Précis de Parasitologie. By E. Brumpt. 5th Edition. Paris, Masson et Cie., 1936. 2 vols., v. 1, xii + 1082 pp.; v. 2, 1083–2139 pp. Illus., plates. Price, 200 frs.

The Précis de Parasitologie is one of the few much appreciated books on parasitology, and the author should be congratulated for this fifth revised edition. As now presented, it has all the admirable qualities of the fourth edition and includes much of what has recently been brought to light as the result of the researches of the numerous workers scattered to the four corners of the world. The illustrations are excellent. Volume 1 devotes about one hundred pages to general problems in parasitology, followed by discussions on the spirochætes, Protozoa, trematodes, cestodes, and nematodes. In volume 2 the annelids, arthropods, and fungi of medical importance are taken up.

—M. T.

Psychology in Questions and Answers. By Rev. Hilarion Duerk. New York, P. J. Kenedy & Sons, 1936. 230 pp. Price, $1.50.

This book is a welcome addition to the many publications already in existence concerning the science of psychology. The method of presentation is quite unique, and simple enough to be understood by lay readers. The title of the book, however, is slightly misleading, for it deals not with the Science of psychology as viewed today by modern psychologists, but with psychology from the standpoint of scholasticism or Catholicism. Thus, to the first question, "What is Psychology?" (page 3) the author answers "Psychology is the science of the soul and its operations or functions through the organisms of the body." Modern psychologists have long ago given up the soul as the subject matter of psychology.

Another example: Question 88 (p. 38) "Does the infant at birth possess an intellect and a free will?" Answer: "The infant from the first moment of conception, according to the more scientific opinion of psychologists, possesses an intellect and free will . . ." "Now, just who are the psychologists whose scientific opinions are referred to?" If the author refers to the scholastic psychologists he is right, but if he refers to the rank and file of modern psychologists the answer is hardly tenable.

The books is, however, intended for students of Catholic institutions. As such it is important, because it presents psychology from the scholastic point of view. The reviewer recommends it, however, to all psychologists in order that they may rightly understand Catholic psychology.—S. G. P.

Psychology of Sex; A Manual for Students. By Havelock Ellis. New York, Emerson Books, Inc., 1937. 377 pp. Price, $3.

This is a well-written manual intended especially for medical students, but it may be profitably used by all students of sex psychology. It is clear and instructive. Although new terminologies are introduced which at first sight may seem strange and foreign to the student, their simple explanation and definition make them easily understood.

The author opens to the student a panoramic view of sex knowledge and its psychology from the earliest philosophers to the modern psycho-analysts. He gives a perspective, clear and encouraging, which only an author of wide experience and knowledge can give. With a bold conclusion he confirms the ideas of other investigators and gives hope to victims of neuroses

due to bad effects of masturbation which are more imaginary than real.

A striking treatment of the subject is the lengthy discussions of normal conditions. The abnormal is dealt with sufficiently to be clearly understood.

In his conclusion he offers no definite remedy for abnormal sexual psychic conditions, although he points out that sublimation may be utilized as one of the promising and effective ways of diverting excess sex impulse. Other supplementary treatments will have to be continued in dealing with sex perversions.
—U. D. M.

Soil Science; Its Principles and Practice Including Basic Processes for Managing Soils and Improving their Fertility. By Wilbert Walter Weir. (Lippincott's Agricultural Science Series) Chicago, J. B. Lippincott Company, 1936. 615 pp., maps, illus. Price, $3.50.

The author of this book has presented a bird's eye view of soil science. A historical development of agriculture and the rise of scientific thought is well treated in the first chapter. The following chapters cover all branches of soil science—chemical, physical, biological, irrigation and drainage, erosion, soil classification, mapping, fertilizers, and others. A wealth of references is listed at every end of the chapter. Tables, illustrations, and pictures made clear some of the interesting facts mentioned.

The chapter on the modern concept of soils discusses briefly the position of soil as an independent, natural, historical body.

This book will make an excellent textbook for students in agricultural colleges. Each subject is treated well and briefly in simple language within the grasp of any undergraduate student.—D. Z. R.

Studies on the Ætiology and Pathogenesis of Cataracta Zonularis. An Academic Treatise by Gunnar von Bahr. Upsala, Almquist and Wiksells Boktryckeri, 1936. 236 pp., plates, diagrs.

This work is a detailed study on the ætiology and pathogenesis of zonular cataract. The morphology, cause, and pathogenesis of this form of cataract are well reviewed, giving special emphasis on the element of heredity in the formation of the type of cataract. Tetany is an important factor in the formation of this opacity of the lens, more so in cases with certain nutritional deficiencies, such as rickets. The formation, once it has begun, will continue in spite of the disappearance of the

tetany. The opacity appears like vacuoles containing an opaque substance. Decrease in the calcium content of the blood does not predispose the case to formation of this lamellar cataract.
—C. D. A.

The Study of the Soil in the Field. By G. R. Clarke. Published under the auspices of the Imperial Forestry Institute, University of Oxford. Oxford, Clarendon Press, 1936. 142 pp. Price, 5s or ₱2.50.

This book gives a comprehensive and concise description and method of studying the soil in the field. As a guide to a soil scientist in the field it gives in detail the fundamental factors required in field observation. The first three chapters deal mainly with the fundamental principle of gathering data in the field.

The chapter on soil survey and mapping describes briefly the steps necessary before going to the field. The last chapter gives a panorama of the various soil-survey systems of several countries. This book should be in the possession of every soil scientist, especially the field man.—D. Z. R.

Training in Industry: A Report Embodying the Results of Inquiries Conducted Between 1931 and 1934 by the Association for Education in Industry and Commerce. Edited by R. W. Ferguson. London, Sir Isaac Pitman and Sons, Ltd., 1935. 156 pp. Price, $1.75.

This book is a general summary of inquiries made in the course of three years from about forty firms and industrial concerns. It is edited by R. W. Ferguson whose work with the Association for Education in Industry and Commerce in England is well known.

The report, consisting of 87 pages, is, as stated in the introduction, a statement of fact and a record of experience, rather than an exposition of theories. The Appendices, in 69 pages, giving the schemes of educational training adopted by fourteen large industrial concerns in England, are instructive and interesting reading. References on the methods used in selecting new employees are also given in the Appendices.

While the book is of particular value to executives of industrial and commercial establishments, it is also of interest to our authorities in connection with vocational education programs of the government. College and university authorities giving commercial and technical courses will find it instructive reading.—A. S. A.

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Yeast Fermentation and Pure Culture Systems. By Stephen Laufer and Robert Schwarz. New York, Schwarz Laboratories, Inc., 1936. 112 pp., illus. Price, $2.50.

This monograph is a practical and yet scientific treatise on yeasts. As stated in the author's preface, it "is intended to serve the practical brewer as a manual that will furnish him the most important information regarding fermentations." It is a very readable book. In going from page to page one cannot help but admire the dexterity of the authors in presenting in such limited space so much valuable information. Both students and professionals will find it a good addition to their lists of references.—M. B.

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A REDESCRIPTION OF THE GENUS MIROGOBIUS HERRE (GOBIIDÆ)

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Herre (1927) established the genus *Mirogobius* to accommodate two new species of small gobies, *M. stellatus* collected from Lanigay, Polangui, Albay Province, January 25, 1926, and *M. lacustris* collected from Laguna de Bay, Laguna Province, in July, 1926. On a field trip of the junior author, from November, 1934 to July 16, 1935, he collected species of transparent small gobies belonging to the genus *Mirogobius* from Paoay Creek and Buttong Lake, Laoag, Ilocos Norte Province. This genus is distributed throughout Luzon, although the bodies of inland waters where its species are found are separate and distinct from each other.

The study of the specimens from northern Luzon and a reexamination of the type specimens of *M. stellatus* and *M. lacustris* collected from Laguna de Bay, warrant a redescription of the genus *Mirogobius*. The reëxamination reveals a greater fin-ray count of the dorsal and anal fins of *M. stellatus* and *M. lacustris* (Tables 1 to 3), the presence of ctenoid scales along the sides of the body of the latter, and the constant vertebral counts in both species of the genus (Table 3).

TABLE 1.—*Fin-ray counts of Mirogobius species, by Herre, 1927.*

Specimens.	Localities, Luzon.	Fin rays.		
		Anal.	1st dorsal.	2d dorsal.
M. stellatus	Lanigay, Polangui, Albay Province	I, 10	IV rarely V	I-7
M. lacustris	Laguna de Bay, Laguna Province	I, 8 to 9	V rarely IV	I-7

TABLE 2.—*Fin-ray counts of type specimens and new specimens of Mirogobius, July, 1935.*

No.	Specimens.	Localities, Luzon.	Fin rays.		
			Anal.	1st dorsal.	2d dorsal.
19	*M. stellatus*	Lanigay, Polangui, Albay Province.	I, 8 to 13	V rarely IV	I–7 to 9
21	*M. lacustris*	Laguna de Bay, Laguna Province.	I, 10 to 13	V rarely IV	I–7 to 9
40	*M. lacustris*	Paoay Creek, Paoay, Ilocos Norte Province.	I, 10 to 13	V rarely VI	I–7 to 9
31	*M. lacustris*	Buttong Lake, Laoag, Ilocos Norte Province.	I, 9 to 12	V rarely IV	I–7 to 8

TABLE 3.—*Vertebral counts of the species of Mirogobius of Luzon.*

Number of specimens.	Species.	Localities, Luzon.	Vertebral counts of each.
19	*M. stellatus*	Lanigay, Polangui, Albay Province	25
20	*M. lacustris*	Laguna de Bay, Laguna Province	25
23	*M. lacustris*	Paoay Creek, Paoay, Ilocos Norte Province	25
24	*M. lacustris*	Buttong Lake, Laoag, Ilocos Norte Province	25

Genus MIROGOBIUS Herre

Mirogobius HERRE, Gobies of the Philippines and the China Sea. Philip. Bu. Sci. Monograph 23 (1927) 91.

Dorsal V, rarely IV or VI; I, 7 to 9; anal I, 8 to 13; skin naked or with minute ctenoid scales along sides of body.

Head robust, blunt, with large oblique mouth; each jaw with a single row of long, stout, curved, widely spaced teeth; a pair of postsymphysial canines in lower jaw behind outer row; in one species canines present only in males; tongue notched; gill openings large, extending along throat; isthmus narrow, branchiostegals five. Body slightly compressed laterally; number of vertebræ 25; dorsals far apart; pectorals rounded; ventrals form subtubulate sucking disc; caudal subtruncate with rounded corners.

Revised key of the Philippine species of Mirogobius.

a^1. A pair of postsymphysial canines present in lower jaw of both male and female; anal I, 8 to 13; dorsal fins V, rarely IV; I, 7 to 9; color darkened by many dark stellate spots............ *M. stellatus* Herre.

a^2. A pair of postsymphysial canines present in lower jaw of male only; anal I, 8 to 13; dorsal fins V, rarely VI; I, 7 to 9; color transparent yellow or creamy white with a few black spots on the head, chin, and along sides of body............ *M. lacustris* Herre.

MIROGOBIUS STELLATUS Herre.

Mirogobius stellatus HERRE, Gobies of the Philippines and the China Sea. Philip. Bu. Sci. Monograph 23 (1927) 92, pl. 6, fig. 4.

Head 3.4; depth 4.2 to 5.2; first dorsal V, rarely IV; second dorsal I, 7 to 9; anal I, 8 to 13.

Body slightly compressed laterally, with an elongate, dorsal profile slightly convex in male, much arched in females; greatest depth at level of first dorsal and ventral.

Head with short, blunt, and rounded snout, equal to eye diameter; eyes lateral, high up; interorbital space broad, equal in eye diameter; mouth large, strongly oblique; lower jaw and chin strongly projecting, with posterior angle of maxillary below front margin of middle eye. Teeth in males and females with postsymphysial canines. Body naked, with tough skin only. Number of vertebræ 25.

First dorsal composed of five, or rarely four, slender spines connected with membranes, the first or the second the longest, the fourth spine slightly shorter than the third, the fifth much shorter than the fourth; the second dorsal falling far short from the first dorsal; second dorsal and anal fins similar in shape, angulate posteriorly, the rays of both of nearly uniform height; caudal bluntly rounded, 4 to 4.5 times in length, shorter than length of head. Pectoral broad, rounded 1.5 times in head; ventrals small, narrow, pointed, subtubulate, 2 times in head. Anal papilla short, thick, cylindrical in females, very elongate, slender and pointed in males.

Color in alcohol varies from yellowish to brownish, with small black stellate spots, with a clear linear space longitudinally from axil of pectoral to the caudal. Top of head, snout, and cheeks, blackish spotted; first dorsal finely specked with dusky or entirely colorless, the other fins more or less thickly dotted with fine black specks, the ventrals colorless.

Nineteen male and female specimens, 16 to 19 millimeters, from the type specimens collected January 25, 1926, at Lanigay, Polangui, Albay Province, have been reëxamined (Table 2).

MIROGOBIUS LACUSTRIS Herre.

Mirogobius lacustris HERRE, Gobies of the Philippines and the China Sea. Philip. Bu. Sci. Monograph 23 (1927) 93, 94; Notes on Fishes in the Zoölogical Museum, Stanford University. Fishes Herre Philip. Exped. 1931 (1934) 81.

Head 3.5; depth 4.3; first dorsal V, rarely IV or VI; second dorsal I, 7 to 9; anal I, 8 to 13.

Body laterally compressed, caudal peduncle elongate, dorsal profile slightly convex; greatest depth at level of first dorsal and ventral.

Head large, blunt, and heavy in males, slender in females, snout very wide and blunt in males, narrower and equally blunt in females; eyes high up and lateral; interorbital space wider than eye diameter; mouth large and strongly oblique with projecting lower jaw, chin strongly rounded and oblique, with posterior angle of maxillary beneath front margin or anterior portion of eye. Teeth in males long, stout, curved, widely spaced; those of the lower jaw visible when the mouth is closed; pair of canines present behind symphysis of lower jaw, back of outer row of teeth; in female minute teeth in one row; pair of inner canines in lower jaw absent. Gill openings large, isthmus narrow, branchiostegals five.

Scales along sides of body microscopic, distinctly ctenoid, with about 4 to 15 spines on their exposed posterior. Vertebræ, 25.

First dorsal, slender spines, second, third, and fourth longest, fifth branched and shortest. First dorsal half the length of second; second dorsal and anal of similar shape, angulate posteriorly, falling far short of caudal when depressed. First anal spine ahead of the first spine of the second dorsal. Pectoral rounded, shorter than the head in length and reaching the level of the last ray of the first dorsal fin. Ventrals fused, with the broad frenum forming a deep sucking disc, 2.5 into the head. Caudal subtruncate, with rounded corners, less than the head in length.

Color in life transparent yellowish, or creamy white with a few black spots on the head, chin, and long dorsal and ventral sides of body, fins colorless.

Color in alcohol creamy white, with black spots on chin, head, and along sides of body.

Twenty-one specimens of *M. lacustris,* from the collection of July 28, 1935, from Laguna de Bay, Laguna Province, 40 specimens collected July 5, 1935, from Paoay Creek, Paoay, and 31 specimens collected July 5, 1935, from Buttong Lake, Laoag, Ilocos Norte Province, have been examined (Table 2).

REFERENCES

HERRE, A. W. Gobies of the Philippines and the China Sea. Philip. Bu. Sci. Monograph 23 (1927).

HERRE, A. W. On the Genus Ctenogobius and Rhinogobius Gill, Tukugobius Herre, and Drombus Jordan and Seal. Science 78 (1933) 265.

HERRE, A. W. Notes on Fishes in the Zoölogical Museum of Stanford University, I. Fishes Herre Philip. Exped. (1934) 84.

ROXAS, H. A. Rediscovery of Biat luzonicus Seal (Gobiidæ). Copeia No. 1 (1935) 19, 20.

THE FISHERIES OF LAKE MAINIT AND OF NORTHEASTERN SURIGAO, INCLUDING THE ISLANDS OF DINAGAT AND SIARGAO

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ONE PLATE AND TWO TEXT FIGURES

Surigao Province (Plate 1) lies along the northeastern part of the mainland of Mindanao. It is elongate in shape, and roughly indented along the northern and eastern coasts by a number of bays and coves. It is separated at its western boundary from Agusan Province by Diwata Mountain. Along its northeastern portion are two large islands; namely, Dinagat and Siargao, both interspersed with many islets in their coves and straits. As the province is rugged and rocky, most of the towns are located along the seacoast, where fishing is one of the important industries.

Around the larger islands and islets, especially in Dinagat Cove and Melgar Bay, fish and shellfish of various kinds are found in commercial quantities during certain seasons of the year. The waters between the islets under the jurisdiction of Dinagat and Surigao are not directly exposed to the prevailing monsoons.

In the mainland, between the provinces of Surigao and Agusan, is Lake Mainit, one of the largest crater lakes in Mindanao and second in size only to Lake Lanao. It lies at 9° 25′ north latitude and 125° 25′ east longitude. It is bounded in the north by the town of Mainit and in the south by Jabonga. The outlet of the lake is located near the latter; along the west is a high mountain ridge, and along the east and south is a portion of the plains of Agusan Province.

The lake is roughly trapezoidal in outline, with an estimated area of about 75 square kilometers. The long diameter extends north and south and measures about 15 kilometers; the short diameter is about 5 kilometers.

The main supply of the water in the lake comes from three main rivers; namely, Pugo, Magpayang, and Sinaiñgan. Abundant rainfall in the locality and a number of small springs emp-

tying into it provide a good supply of water in the lake. The outlet, Jabonga–Tubay River at its southern end, flows into another lake, Lake Pagusi. This lake has an approximate area of about 4 square kilometers. It derives its name from a water lotus, called *pagusi* (*Nymphæa* sp.), with which it is mostly covered. Only a few people fish in this lake because of the abundance of crocodiles.

Lake Mainit is surrounded by gradually sloping, sandy and gravelled shores, except for a portion along the eastern border, called Kabatohan, which is roughly indented, stony, and rocky. The shore along the western border is abruptly sloping. There are, however, some parts along the mouths of rivers flowing into the lake where muddy bottom may be found. The water of the lake is very clear, and the surface stands about 82 feet above sea level during the greater part of the year. The shore is narrow, except along the northern and eastern sides, and descends abruptly to a considerable depth. About a kilometer from the shore, according to fishermen, a depth of 15 to 20 brazas has been recorded. The greatest depth is, however, reported to be about 82 brazas (150 meters).

The lake is rich in plant life. Along the littoral area tape grass (*Vallisneria* sp.) and cat tails (*Ceratophyllum demersum* Linn.) are abundant. Water lotus and a few water hyacinths abound near the mouths of rivers. Filamentous algæ are found on the littoral area, growing on the gravelly and sandy bottom. The presence of these filamentous algæ in abundance in many portions of the lake is, undoubtedly, an ideal condition for the growth of bañgos (*Chanos chanos* Forskål). It is surprising, however, that, although balanak (Mugilidæ) abound in the lake during certain seasons of the year, no catch of bañgos has been recorded, probably due to the exceptionally high elevation of the lake, which makes it impossible for young bañgos going upstream to reach it.

FISHERIES OF LAKE MAINIT

Although there is no record of fish caught in this lake, its fisheries must have played a significant rôle in the economic life of the inhabitants. Both the fishermen and municipal officials, especially those residing along the Jabonga River, believe that there has been a gradual decline in the catch from the lake and its outlet, accompanied by the gradual disappearance of the few commercial species that used to abound there.

In spite of the fact that fishing has been carried on in the lake since the early days of the Spanish regime and probably even earlier, no restriction of any form to conserve the fishery resources of the lake has been imposed by the constituted authorities. With the rapid increase in population around the lake and neighboring provinces, the fishery will be subjected to further strain, and if adequate conservation measures to increase or rehabilitate the fishery resources of the lake are not put into effect, the latter are bound to be exhausted.

Lake Mainit is under the jurisdiction of the municipality of Mainit, Surigao Province, and of Jabonga, Agusan Province. Since the recognition of the municipality of Mainit in 1910, ordinances relating to the taxation for the privilege of fishing in the lake have been enforced on different fishing appliances.

Along the southern end of the lake where the outlet is located, the Municipal Council of Jabonga opens a yearly lease for the privilege of fishing in Jabonga River and along the shores of the lake under its jurisdiction. The leasing of the mouth of Jabonga River began in 1920 with a yearly fee of 250 pesos. A fish corral is constructed at the mouth to catch fishes migrating to the sea. Since 1920 the fee has increased constantly, due to to the increasing number of bidders. During the survey (1936) the fee was set at 1,350 pesos per annum.

The lower portion of Jabonga River, called Tubay River, belongs to the municipality of Cabadbaran. Along this river there are a number of *pasakis* and *paluksuhan* (fish corrals) set across the stream to catch fishes migrating to the sea. These fish corrals are also leased to the public for 20 to 30 pesos each a year.

No steps toward the conservation of the fishery were taken until an ordinance was passed by the provincial board, providing, among other things, a gateway of 10 meters along one side of the river to serve as an escape for migrating fishes and as a passage way for barotos and launches navigating along the river.

The principal species found in the lake are *pidianga* (*Glossogobius* spp.); *balanak* (*Mugil* spp.); *guingao* (*Lutianus argentimaculatus*); *lañgob* (*Caranx* spp.); *casili* (*Anguilla mauritiana*); and *haruan* (*Ophicephalus striatus*). The following are caught in lesser quantities: *puyo* (*Anabas testudineus*); *kikilo* (*Scatophagus argus*); *bakoko* (*Pomadasys hasta*); *hipon* (Gobiidæ); *buagan* (*Ophiocara* sp.); *bolinao* (Phallostethidæ); *pegok* (*Therapon* sp.); *danutan* (Leiognathidæ); *pantat* (*Clarias batrachus*); *suasib* (Hemiramphidæ); and *gabot* (*Rasbora* sp.).

Snails, mostly *hapiosan* (*Vivipara angularis*) and *cabuay* (*Ampullaria* sp.) abound in the lake. Shrimps (*Palæmon* sp.) and *uyap* (*Palæmon* sp.) are occasionally caught. The abundance of snails in the lake may give rise to a flourishing duck industry in the future.

The more important fishes caught in the lake, together with a conservative estimate of the income derived from each, and their fishing seasons, are shown in Table 1.

TABLE 1.—*Important fishes caught, income derived therefrom, and fishing seasons in Lake Mainit.*

Common name.	Family.	Annual income.	Season.
		Pesos.	
1. Pidianga	Gobiidæ	12,000	Throughout the year.
2. Guingao	Lutjanidæ	8,000–10,000	April to May.
3. Lañgob	Carangidæ	3,000– 5,000	Throughout the year.
4. Balanak	Mugilidæ	3,000– 5,000	December and January.
5. Casili	Anguillidæ	1,000– 2,000	December to February.
6. Miscellaneous		5,000	Throughout the year.
Total		32,000–39,000	

The total value of the fisheries of Lake Mainit is conservatively estimated at about 40,000 pesos annually.

COASTAL FISHERIES

The municipal income from coastal fisheries is derived from the license fee levied on the various fishing appliances used in their respective localities. As elsewhere in the Philippines, there is no actual record of the catch of each gear. Only recently a campaign for the collection of fishery statistics, with the cooperation of the provincial and municipal treasurers, has been started in Fishing District No. 9, which comprises northern Mindanao and Davao Provinces.

TABLE 2.—*Income by municipalities from fisheries for 1935.*[a]

	Pesos.		Pesos.
Bacuag	165.50	Lingig	156.00
Bislig	149.80	Loreto	247.50
Cantilan	112.50	Mainit	126.95
Carascal	205.50	Numancia	158.00
Dapa	425.00	Placer	425.05
Dinagat	1,108.00	Surigao	432.70
General Luna	78.20	Tago	67.50
Gigaquit	154.50	Tandag	121.00
Hinatuan	570.50		
Lanuza	20.00	Total	5,071.20
Lianga	327.00		

[a] Data by courtesy of the Provincial Treasurer of Surigao Province.

Table 2 shows that Dinagat, Hinatuan, Surigao, Placer, and Dapa, named in the order of their importance, are the towns where fishing as an industry is active and extensive.

Dinagat.—Dinagat is a small town located on Dinagat Island. As the island is thickly forested and rocky, the main occupations of the people are fishing and lumbering. Very recently chromite deposits were located in the regions around Dinagat, and many people began to turn their attention to mining. Primarily, however, Dinagat is a fishing town, its fisheries being confined in and around the islets of Cabilan, Capaquian, and Rizal. As a matter of fact, this region, including Melgar Bay, is considered the best fishing center of northeastern Surigao Province.

Deep and shallow fish corrals dot the coves and bays of Dinagat Island during the northeast monsoon. Anchovies (*dumodot*), mackerel (*haul-haul*), sardines (*tamban-tuloy*), two-finned runners (*salindatu*), and *tuliñgan* (Thunnidæ) are caught in abundance from November to April. Although the last-named species is caught almost throughout the year, it is most abundant from January to April when sardines are also caught with them.

The *lampara, lawag,* or *sapiao* is extensively used in Dinagat Island. It must have been introduced by the fishermen from Leyte and Samar. During the survey (November to December, 1936), 34 lamparas with from 500 to 1,000 candle power were in operation. A lampara outfit pays an annual license of 60 pesos to the municipality of Dinagat. The catch of lampara, which consists principally of anchovies, is mostly salted and marketed in Bohol, Cebu, and Surigao. Very little of the fresh catch is marketed locally.

In Barrio Osmeña extensive diving is done by natives for mother of pearl and *Trochus*. The pearling grounds are reported to be quite extensive.

Loreto.—Loreto is another small town, located at the northern end of Dinagat Island. It is primarily a fishing town, situated at the head of Loreto Cove. Tuliñgan, *trakito,* dumodot, and tamban-tuloy are caught in fairly large quantities by fish corrals. Lampara is also used in small shallow coves. Trolling in Surigao Strait is extensively done in times of fair weather.

Whales, probably the black-fin, are reported to be caught near Loreto during the summer months (March to May). Stranded whales are frequently reported between Desolation Point and Homonhon Island.

Surigao.—Surigao, the capital of the province, is located at the head of a cove. It is the market center for agricultural and fish products, and its municipal waters are rich fishing grounds. The barrios of Lipa, Sabang, Lipata, and Ipil are the most important fishing banks of Surigao. Ipil is worth mentioning here for its valuable *nocus* (*Loligo* sp.) fishery, which yields an approximate income of about 5,000 pesos yearly.

The nocus is principally caught by pukot throughout the year. A pukot outfit of 10 by 50 brazas costs from 400 to 500 pesos. It is operated very much like the *sapiao con luces*. Strong lights, ranging from 500 to 1,000 candle power, are used in connection with the operation of this pukot. Nocus fishing is only possible during the dark of the moon and when the sea is calm and the water clear.

Dangit (*Amphacanthus* sp.) is caught by shallow-water fish corrals (*pahubas*) from December to April, when inshore winds prevail. From August to October no fish corrals can operate in the municipal waters of Surigao on account of the strong southwest monsoon.

Infrequently, muro-ami fishermen from Mambajao, Camiguin, operate in some suitable portions of Surigao, and their enormous catch is usually marketed there. When they have enough ice in their hold, large catches are taken to Mambajao, Catarman, and Sagay.

The eastern portions of Surigao proper are wide strips of marshy land, suitable for bañgos raising. From Lipata point to Surigao River there are about 400 hectares of timber block which can be very well developed into bañgos fishponds as population and demand for fish increase.

Baling, bungsod, lampara, and *pukot* are the most important gear used in the locality.

Placer.—Placer is a mining town, located at the head of a semiopen cove. This place is for the most part protected from the northeast monsoon by the islands of Lakandola, Talavera, and Opong. Fishing is a minor industry, in spite of the fact that the waters teem with many commercial species of fish. Most of the laborers in the locality are recruited into the mining industry.

Both shallow and deep fish corrals are found around the small islands of Lakandola, Talavera, and Opong. In this locality lampara is also extensively used for catching anchovies and sardines almost throughout the year. When large hauls of those

fishes are taken, they are marketed in Badas, the junction of the three roads from Surigao, Mainit, and Placer.

The sea bottom of the coastal region is more or less stony, in most parts inhabited by several kinds of rock fishes. Various kinds of fish traps, such as *panggao* and *liguid,* similar to those used in the Visayan Islands, are frequently employed.

Mother of pearl, *Trochus,* and other kinds of commercial shells have been reported abundant around the small islands under the jurisdiction of Placer.

Bacuag.—Bacuag is a small agricultural town about 15 kilometers from Placer along the shore. Although fishing is not a very important industry there, baling and lampara are sometimes employed for catching anchovies and round herrings (Dussumieridæ).

Gigaquit.—Gigaquit is a mining town about 20 kilometers from Bacuag. Fishing is not carried on very extensively there. However, a few shallow fish corrals and baling are used by a number of fishermen for catching mackerel, sardines, and sometime tuliñgan.

Siargao.—Siargao is a small island about the size of Siquijor Island, with the important fishing municipalities of Dapa and Numancia located along the southwestern coast.

Bungsod, lampara, and baling are the most common gear used for catching *dumodot* (anchovies), *haul-haul* (sardines), and *tegué* (*Scutengraulis* sp.). The important fishing grounds are around the small islets west and south of Siargao and around Bucas Grande Island.

FISHING METHODS

In Lake Mainit, its tributaries, and its outlet, the fishing gears used are baling, paluksuhan or *bisig,* bungsod, *dumpil, salibot,* and *sarap.*

Baling.—The baling (chinchorro in the Visayan Islands) is a drag seine made of woven abacá. It is provided with a long conical bag flanked by two long tapered wings of equal size. It is operated by six to ten men along the shallow sandy shores of the lake. The head ropes are provided with wooden floats, and the bottom with lead sinkers. A complete outfit costs from 30 to 40 pesos, including two small *barotos.*

The major catch consists of pidianga admixed with bolinao and buagan.

Paluksuhan (*text fig. 1*).—The paluksuhan or *bisig* consists of a barricade with two wings and a catching trap at the rear. This is set across shallow flowing streams to catch fishes going down

stream to the sea to spawn. The barricades are made of wooden poles with fillings of stones along their bases in order to keep them from being carried away by strong floods. The terminal portion consists of a sliding platform and a collecting trap (*abo-abo*). The sliding platform is made of *banata* set as flooring with an inclination of about 30 degrees. When a migrating fish

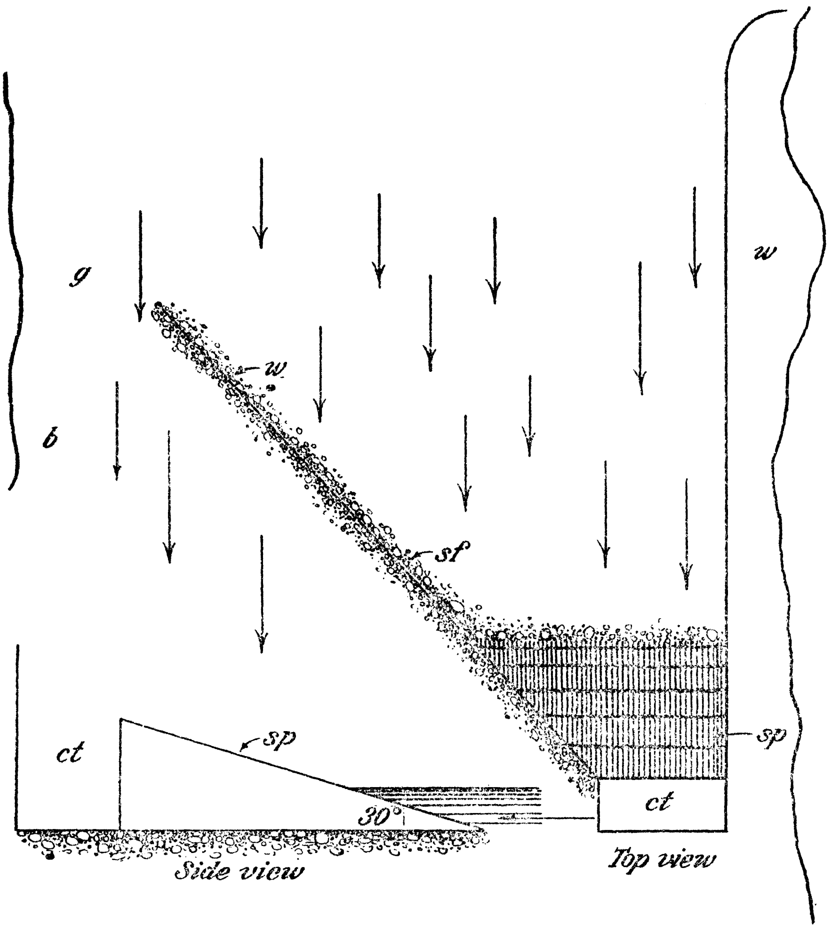

FIG. 1. Diagram of paluksuhan. *w*, Wing (pañgampac); *sp*, sliding platform; *ct*, collecting trap (abo-abo); *g*, gateway; *b*, river bank; *sf*, stone fillings.

touches the platform, it is tossed to the collecting trap by its own force.

During the survey in December, 1936, there were about five traps of this kind along the Jabonga-Tubay River. These traps are set not less than 200 meters apart as required by the municipal ordinance of Cabadbaran, Agusan.

Bungsod (*text fig. 2*).—Bungsod is a fish corral seldom used in the lake proper because the bottom of the lake is sandy and the shoreline very narrow. At the mouth of Jabonga River, a bungsod is constructed in a similar way as the *baklad* of Butas River in Mindoro and Pansipit River in Batangas. It has a wing

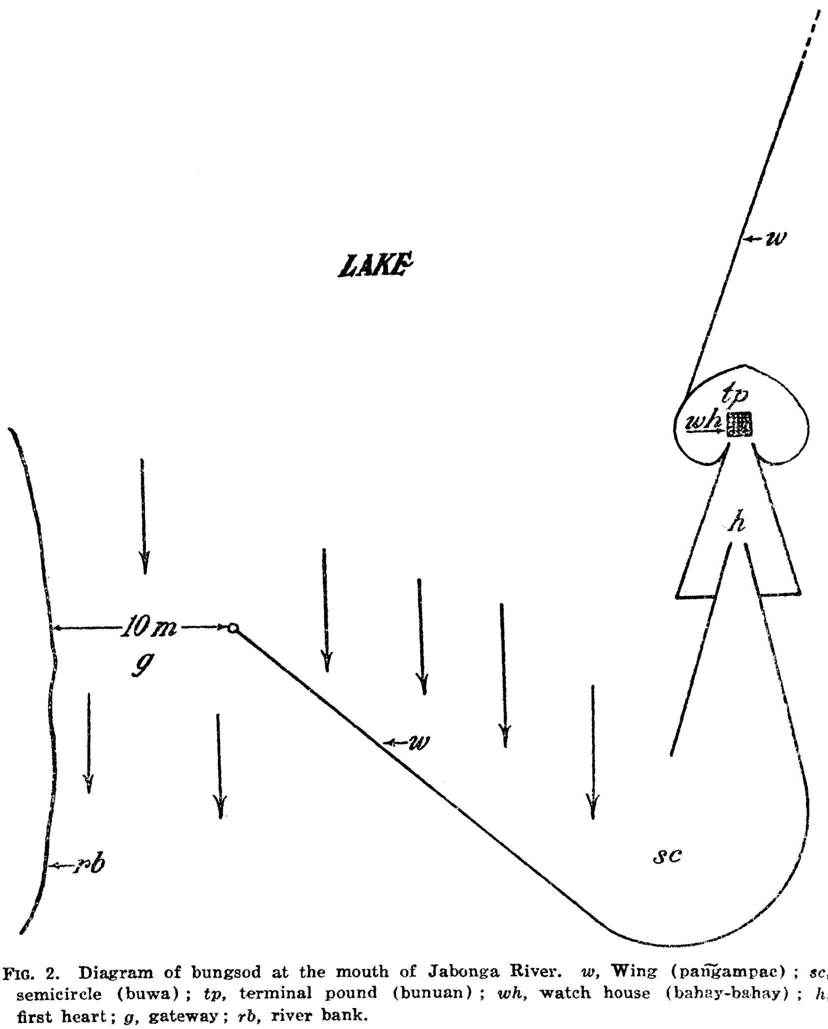

FIG. 2. Diagram of bungsod at the mouth of Jabonga River. *w*, Wing (pañgampac); *sc*, semicircle (buwa); *tp*, terminal pound (bunuan); *wh*, watch house (bahay-bahay); *h*, first heart; *g*, gateway; *rb*, river bank.

almost closing the mouth of the river and a terminal pound on one side. A watch house is constructed on top of the terminal pound.

The catch consists principally of casili, lañgob, guingao, balanak, haruan, and bulan-bulan.

The operation of this bungsod at the mouth of Jabonga River gives a good income to the municipality of Jabonga from leases.

Dumpil.—The dumpil consists of two bamboo screens (*banata*) set in a semicircle at the end of a dug-out canal or in small streams. It catches haruan only when the water of the lake rises to the level of the canals.

Salibot.—The salibot is a small rectangular net made of cotton twine (Nos. 20 and 40), provided with wooden floats and lead sinkers. It is operated like a drag seine. In some places the salibot is called *pukot.* It catches, for the most part, haruan and pantat. Two to four men are needed to operate the outfit.

Sarap.—The sarap is a scissor net made from woven abacá locally called *baliñgonon.* It is operated by a single person along the banks of Jabonga-Tubay River. The catch consists mostly of uyap and larval fishes.

Fishing in northeastern Surigao, as in other regions of northern Mindanao, is confined to the region along the shore. Fishing is mostly carried on in dug-out bancas which cannot stay out at sea more than one day, and which cannot withstand bad weather conditions. The nets used are generally made of finely woven abacá cloth (baliñgonon), which is much cheaper than cotton-thread nets. Most of the gear used locally were perhaps introduced by the fishermen from Luzon and Visayan Islands.

Only the important gear and those extensively used are mentioned in the following paragraphs.

The lampara.—The lampara is considered the most important fishing gear used in Surigao, especially in and around the vicinities of Dinagat cove and Melgar Bay, where anchovies are caught in commercial quantities. Anchovy fishing commences as early as October and extends up to March.

A lampara outfit consists of the lamparahan and a net or *baling.* The lamparahan consists of two dug-out bancas which are connected by a sort of platform with a mounted tripod rack on which the lamp (lampara) is hung. A lamparahan may be provided with one or two "Hasag" or "Petromax" lamps, with 500 to 1,000 candle power. Besides being used as a landing platform, the lamparahan is used for loading and transporting the net and catch to and from the fishing ground.

The net or baling consists of a rectangular beach seine of abacá cloth, which is operated in a similar way as the *sapiao con luces.* It is usually about 200 feet long and 15 feet wide at the wings and 25 feet at the bunt. The sides of the net are selvaged with hand-made abacá twine about one-eighth inch

in diameter with a mesh of about two inches stretch. The upper line is provided with wooden floats and the bottom with lead sinkers. The ends of the wings are provided with pull ropes for hauling in the net. In operation it is converted into a huge dip net hauling in the bottom line.

From six to ten men are needed to operate the net. These men set out to sea early in the afternoon, and upon reaching the fishing ground, about dusk, they light the lampara. The lamparahan drops anchor and lies in wait, while most of the crew go to sleep. One man, usually the steerman, is assigned to watch the light. When large schools have been attracted, the steerman wakes up the rest of the fishermen. The lampara escorts the school into the net which has been laid out in the form of a semicircle. When the school of fish has been enclosed, the bottom ropes are pulled to form a sort of dip net; then the net is hauled in until the fish are impounded in the bunt, whence they are brailed out by means of dip nets (*sigpao*).

A lampara outfit involves the following expenditures: For the lampara (one lamp, 1,000 candle power), 60 pesos; for the net (including all accessories), 40 pesos; for the lamparahan (two barotos), 40 pesos; or a total of 140 pesos. One 1,000-candle power lamp consumes 30 to 40 centavos worth of petroleum a night.

The catch consists chiefly of anchovies mixed with a large amount of larval forms of other fishes. The value of anchovy fisheries alone in Dinagat cove and Melgar Bay may be placed at from 10,000 to 20,000 pesos every fishing season.

The bungsod (fish corrals).—This fishing appliance used in the coastal waters of Surigao Province is next in importance to the lampara. It is usually placed in position from November to March and removed at the commencement of the southwest monsoon in May or June.

Various types of bungsod are in use. The most common forms employed are the *tinagalog* or *paugmad*, the *pandomodot*, and the *pahubas*.

The tinagalog, as its name indicates, is a fish corral introduced by the Tagalogs. It is primarily adapted to waters varying from 5 to 10 fathoms in depth. This type is not usually provided with a pound or crib. The catch is taken by brailing with the use of a drag net, locally called *siguin*. This kind of fish corral may cost from 1,000 to 3,000 pesos, depending upon its size and the depth of its location.

The fish corral pandomodot derives its name from *domodot*, an anchovy, which forms its principal catch. It is similar to the *inangcla* type of fish corral used in Samar and Leyte. It is set in waters of from 2 to 6 fathoms in depth. It may have one or two pounds on each side. It requires an investment of one to two hundred pesos.

The pahubas is a shallow type of fish corral set along the shallow tidal flats (*hunasan*) frequented by fishes, such as dangit (Amphacanthidæ), goatfishes (Mullidæ) and other rock fishes. It consists of a terminal pound with two semicircular inclosures superimposed upon the former, and with two diverging wings. A pahubas may cost from thirty to fifty pesos.

Baling.—The baling consists of a beach seine of abacá cloth, operated very much like the pukot in Luzon. It may or may not be provided with a bag (*supot*). It is operated on smooth, sandy or muddy bottoms, by from six to ten men, depending upon the size of the outfit. When it is operated at night a strong light is used with it.

FISH-PRESERVATION METHODS

The fish caught in Lake Mainit are much in demand in the nearby towns, and most of them are sold in the fresh state. Pidianga, which are frequently caught in considerable quantities, are sold in the fresh state in Mainit and Badas. However, during the height of the fishing season of balanak and guingao, when there is an oversupply of fresh fish, they are salted, dried, and marketed in the neighboring inland towns of Surigao and Agusan.

In Dinagat cove and Melgar Bay, where large hauls of anchovies and round herrings are made, fish preservation is very important. During the survey, however, no regular preservation plants similar to those found in Estancia and Catbalogan were seen. The enormous catch are usually salted in the houses of individual fishermen.

The most common methods of fish preservation are drying and salting. The former method is used with big fishes, such as *anduhao* (Scombridæ) and *tamarong* (Carangidæ), which are frequently caught in big quantities. The fish is opened at its back, salted, and dried under the sun. Anchovies are seldom dried; they are prepared into a popular product locally called *guinamos*.

Two methods of salting are employed in making guinamos in Dinagat; namely, the *sinabado* and the *jinusto*. When the guinamos is intended for short storage, the ratio of two gantas of salt to one ganta of fish (anchovies) is used. This *sinabado* method is also resorted to when there is a shortage of salt.

In the jinusto method, the ratio of three gantas of salt to one ganta of fish is used.

In the making of guinamos the fish is first washed in sea water to remove any dirt or foreign material that may be clinging to it. The bigger fishes are removed in order to assure a uniform rate of fermentation. Salt and fish are thoroughly mixed in proper proportions on a mat or in one end of a banca. Then the mixture is packed in petroleum cans. After two or three days the cans are sealed. They are marketed in Bohol and Cebu where there is a great demand for them. A can of guinamos costs from 1.50 to 2 pesos.

FACTORS OF DEPLETION IN LAKE MAINIT FISHERIES

Overfishing and depletion of both the breeders and fry are the main factors that affect the supply of fish in a given body of water. Sometimes some natural environmental factors also affect the abundance of fish. Dry seasons are at times responsible for wholesale dying of fishes in the lake. When the temperature is high, the rate of algal multiplication is rapid, so that during the dry season, when the volume of water in the lake is less, the amount of algæ per unit volume of water is great. At night, especially when there is no photosynthetic liberation of oxygen, the amount of oxygen in the water becomes less than the minimum requirement of the fish in the lake. The dead and putrifying algæ possibly also liberate poisonous substances. These conditions, together with the low oxygen content of the water, perhaps lead to the death of fishes. Similar conditions have been noted in Lake Naujan and Laguna de Bay during the summer months.

Because of the depth of the lake there is no danger of seriously depleting its permanent fish residents. The migratory species, however, have already shown signs of decline. The fish corral at the mouth of Jabonga River catches almost all migrating fishes. The sarap along the Jabonga-Tubay River also catches the fry of these migratory species. These destructive practices of the fishermen are mainly responsible for the depletion of the fisheries of the lake and the river.

The decrease in the supply of fish and the gradual disappearance of certain commercial species are now being complained of by the residents of Mainit and Jabonga, although this apparent decline cannot be shown by statistics due to the absence of reliable records. Fluctuations occur, as is to be expected, in any fishery. As long as the record of catch per unit of gear or effort and the statistics of catch are unknown, the actual rate of depletion cannot be determined.

As far as can be ascertained, the alleged decrease in the quantity of fish supply in the lake may be attributed to the following: (1) A gradual lowering of the water level of the lake during recent years; (2) bad water brought about by the decay of algæ during certain seasons of the year; (3) the increase in population around the lake, which has intensified fishing activity and which in turn has taxed to the limit the capacity of the species to maintain themselves; and (4) the unrestricted catching of both the breeders and fry of migratory species.

RECOMMENDATIONS

The following recommendations, if followed, might serve to remedy the present situation of Surigao fisheries, and may likewise increase the fish population in Lake Mainit.

1. For the protection of the fry of the fishes, principally those of the migratory species, the use of sarap along the Jabonga-Tubay River should be prohibited.

2. For the protection of both the fry and the breeders, the two mouths of Tubay River, Cabadbaran, Agusan Province, should be declared fish reserves or sanctuaries. The reserved area should cover at least 50 meters on each side of the mouth and a radius of about 100 meters toward the sea, drawn from the base of the mouth, and 100 meters inside the river.

3. An extensive campaign against the use of fish poisons (*tubli* and *lagtang*) should be undertaken in order to minimize the destruction wrought by these poisons.

4. Studies on the migration and biology of important species should be undertaken in order that proper legislation may be promulgated.

5. Transplantation of young bañgos should be experimented with. If it proves successful, it will increase the number of bañgos breeders in Butuan Bay and likewise the fish supply in the lake.

6. The important fishing bank in northeastern Surigao, around Dinagat Cove and Melgar Bay where the anchovy is most abundant, should be exploited.

7. The mother of pearl and *Trochus* fisheries in and around Dinagat Island and possibly around the small islets under the jurisdiction of Surigao should be developed.

8. Studies on the habits and life histories of the more important fishes along the shores should be undertaken in order that proper protective regulatory measures may be formulated and enforced.

9. The eastern coastal regions of Surigao proper and around the numerous islets are rich in corral reefs which teem with various commercial species of rock fishes and should be recommended for muro-ami fishing.

10. Suitable places for bañgos culture between Lipata Point and Surigao River should be developed and utilized to stabilize the fish supply.

11. In making guinamos, the people should be made to observe sanitary rules, to use a better quality of salt, and to employ earthen jars in fermenting the fish.

ILLUSTRATIONS

PLATE 1

Map of northeastern Mindanao, showing Lake Mainit and adjacent islands.

TEXT FIGURES

FIG. 1. Diagram of paluksuhan. *w*, Wing (pañgampac); *sp*, sliding platform; *ct*, collecting trap (abo-abo); *g*, gateway; *b*, river bank; *sf*, stone fillings.

2. Diagram of bungsod at the mouth of Jabonga River. *w*, Wing (pañgampac); *sc*, semicircle (buwa); *tp*, terminal pound (bunuan); *wh*, watch house (bahay-bahay); *b*, first heart; *g*, gateway; *rb*, river bank.

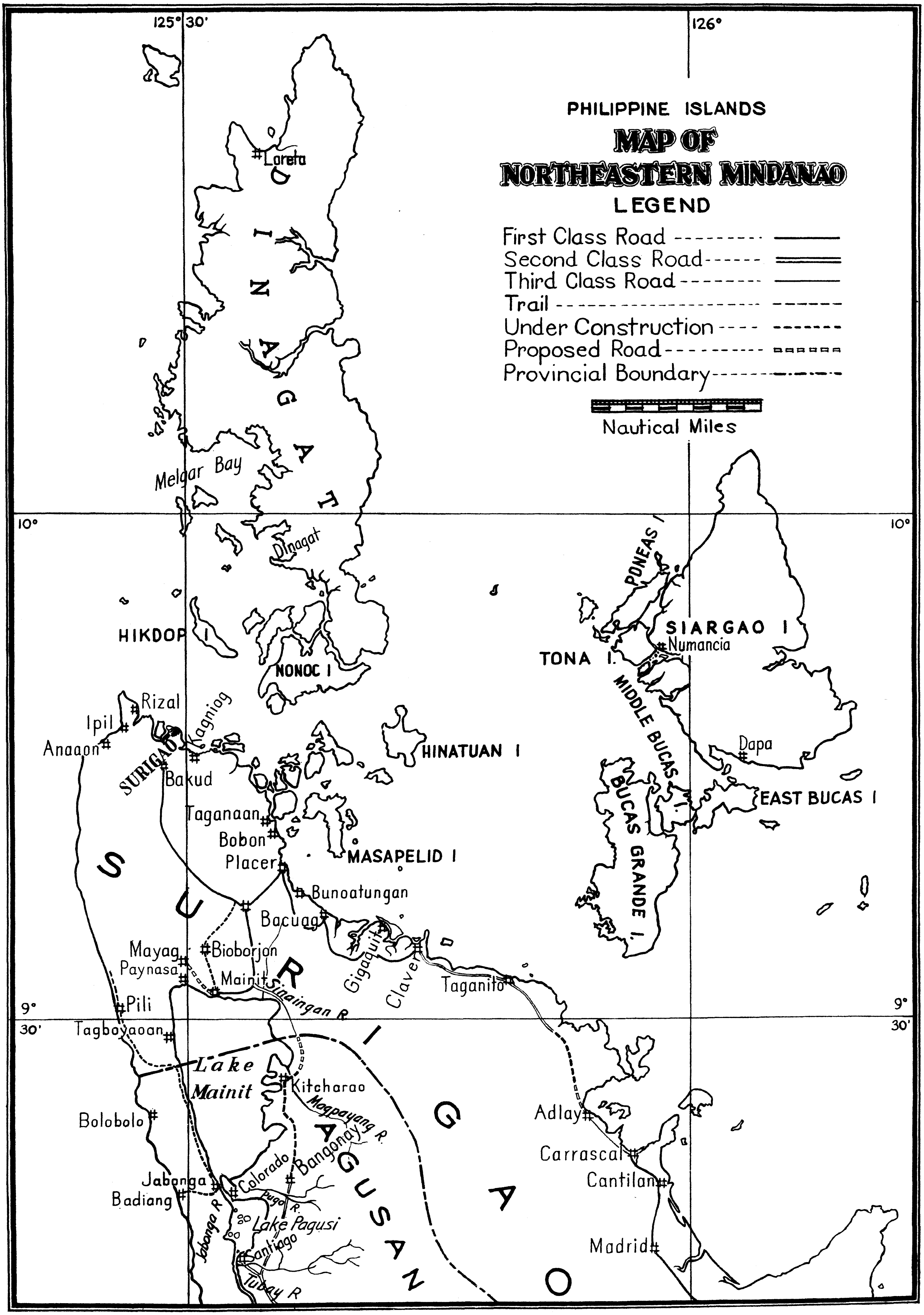
PHILIPPINE ISLANDS
MAP OF
NORTHEASTERN MINDANAO
LEGEND
First Class Road
Second Class Road
Third Class Road
Trail
Under Construction
Proposed Road
Provincial Boundary
Nautical Miles
125° 30'
126°
10°
9°
30'
DINAGAT
Loreta
Melgar Bay
Dinagat
HIKDOP I
NONOC I
HINATUAN I
MASAPELID I
PONEAS I
SIARGAO I
Numancia
TONA I.
MIDDLE BUCAS I.
BUCAS GRANDE I.
Dapa
EAST BUCAS I
Rizal
Ipil
Anaaon
Kagniog
SURIGAO
Bakud
Taganaan
Bobon
Placer
Bunoatungan
Bacuag
Gigaquit
Claver
Taganito
Mayag
Paynasa
Bioborjon
Mainit
Sinaingan R
Pili
Tagbayaoan
Lake Mainit
Kitcharao
Magpayang R.
Bangonay
Colorado
Pugo R.
Lake Pagusi
Cantiago
Tubay R
Jabonga
Badiang
Jabonga R
Bolobolo
SURIGAO
AGUSAN
Adlay
Carrascal
Cantilan
Madrid

PLATE 1.

PYGIDIOPSIS MARIVILLAI, A NEW HETEROPHYID TREMATODE FROM THE PHILIPPINES

By Pedro G. Refuerzo and Eusebio Y. Garcia

Of the School of Hygiene and Public Health, University of the Philippines Manila

ONE PLATE

While investigating, in connection with other work, the parasitic fauna of the small intestines of different Philippine fish-eating birds, we encountered in a white-breasted sea eagle, *Haliæetres leucogaster* (Gmelin), several flukes, apparently of the same species of the genus *Pygidiopsis* Looss. Since 1907, when Looss erected this genus for the species *P. genata,* no other species had been found. The name *Pygidiopsis marivillai* is proposed for our Philippine species.

PYGIDIOPSIS MARIVILLAI sp. nov. Plate 1, fig. 1.

The present description is based on thirty-two adult specimens obtained from the small intestine of a white-breasted sea eagle, *Haliæetres leucogaster* (Gmelin), caught in Pandacan, Manila.

Body small, 0.36 to 0.45 by 0.16 to 0.23 millimeter, oblong in normal state of distention (pear-shaped when flattened), with a ventrally concave anterior portion and an enlarged (almost globular) posterior one, all the reproductive organs confined in the latter region. Cuticle beset with minute scalelike spines thickly set anteriorly, gradually fading out towards the distal fifth of the body. Oral sucker subterminal, 0.03 to 0.04 by 0.04 to 0.05 millimeter, ornamented with a single circlet of 8 to 14 delicate spines; pharynx longitudinally oval, 0.017 to 0.035 by 0.017 to 0.024 millimeter; œsophagus long, 0.035 to 0.080 by 0.011 to 0.014 millimeter; intestinal cæca simple, as large as the œsophagus in diameter, terminating blindly shortly in front of the testes.

Female reproductive organs.—Ovary transversely oval, 0.049 to 0.067 by 0.042 to 0.046 millimeter, on the right side of the median line, in front of right testis. Receptaculum seminis spherical to transversely oval, 0.045 by 0.035 millimeter to the left of the ovary, median or slightly to the left of the median

line, in front of left testis. Uterus long, thrown into coils between testes and ventrogenital sac. Vitellaria consist of two rows of glands, each having from 7 to 8 coarse follicles disposed of more or less longitudinally between the corresponding testis and the posterolateral border of the body.

Male reproductive organs.—Testes transversely oval, 0.070 to 0.081 by 0.046 to 0.049 millimeter, lying side by side near distal end of body. Seminal vesicle well developed, divided by a constriction into two portions, situated one behind the other between the ventrogenital sac in front and the ovary and receptaculum seminis behind. Ventrogenital sac more or less median, occupied mostly by a globular ventral sucker, 0.045 to 0.052 millimeter in diameter. Lenticular-shaped body (gonotyl) protrusible, usually in the left anterolateral angle of the sac, about twice as big (0.098 millimeter) as the ventral sucker, adorned with two curved rows (one near each opposite border of gonotyl) of closely set, bluntly pointed chitinous bars, 11 to 12 in each row; each bar measuring 7 to 11 by 4 to 6 microns. Excretory bladder T-shaped. Eggs oval, brown, thin-shelled, 21 to 25 by 7 to 11 microns.

Specific diagnosis—Pygidiopsis: Body pear-shaped, small, 0.36 to 0.45 by 0.16 to 0.23 millimeter, oral sucker with a single circlet of 8 to 14 delicate spines; intestinal cæca simple, terminating blindly in front of testes; ovary transversely oval, on right side of median line, in front of right testis; receptaculum seminis spherical to transversely oval, median or immediately in front of left testis; uterine coils between testes and ventrogenital sac; testes transversely oval, lying side by side near distal end of body; ventrogenital sac with ventral sucker more prominent; lenticular-shaped body about twice as big as ventral sucker, having a double row of coarse, closely set, bluntly pointed chitinous bars each measuring 7 to 11 by 4 to 6 microns. Excretory bladder T-shaped. Eggs small, 21 to 25 by 7 to 11 microns.

Host.—*Haliæetres leucogaster* (Gmelin).

Location.—Small intestine.

Locality.—Pandacan, Manila.

Type specimen.—Parasitological collection, Department of Parasitology, School of Hygiene and Public Health, University of the Philippines.

Remarks.—When Looss (1907) erected the genus *Pygidiopsis*, it had only a single species; namely, *Pygidiopsis genata* Looss, 1907. The present material, if considered valid, represents the second species, and differs from *genata* mainly in the size and

pattern of the gonotyl. According to Witenberg (1929), the ventral sucker of *P. genata* has the same dimension (0.04 to 0.06 millimeter) as the long axis of the gonotyl. In our specimen the long axis of the latter organ is about twice as long (0.09 millimeter) as the diameter (0.04 to 0.05 millimeter) of the ventral sucker. Unfortunately, however, the descriptions by Looss (1907), Ransom (1920), Linton (1928), Witenberg (1929), and Ciurea (1933) of the structure of the gonotyl of *P. genata* are either too incomplete or too misleading to enable us to establish a more accurate differentiation from the same organ of our material. For instance, *Ascocotyle plana* Linton, which was absorbed into the genus *Pygidiopsis* by Witenberg (1929) as a synonym of *P. genata* following his revision of the trematode family Heterophyidæ Odhner, was first described by Linton (1928) as possessing a "cirrus-pouch," an organ which is altogether absent among the heterophyid flukes. Ciurea (1933), on the other hand, opines that folds having the appearance of tiny rodlets disposed radially and formed by the cuticle, line the degenerated genital sucker which is found in the interior of the sinus.[1] But Witenberg (1929), although failing to define thoroughly this organ, seems to show in his text figure certain characters that may be of value in differentiating our material. According to his illustration on page 186, the gonotyl bears chitinous bars, which are fine, few in number, set far apart, and found at the border;[2] the chitinous bars in our specimen are coarse, more in number (11 to 12 bars in each row), closely set with their ends bluntly pointed, and situated on the surface, suggestive of the gonotyl of *Haplorchis taichui* Nishigori, 1924. Owing to the variability of opinions, the senior author finally communicated with Professor Faust, who kindly lent him from his collection three specimens of *P. genata* obtained from a dog in Canton, China. A careful study of the three specimens revealed a conspicuous lenticular-shaped gonotyl, minus the chitinous rodlets.

The form of the ovary and the extent of the intestinal cæca also serve to differentiate our species from *P. genata*. In *P. genata* the ovary is globular and the intestinal cæca reach only

[1] A l'interieur du sinus, on trouve une ventouse génitale dégradée, tapissée par une cuticule qui forme des plis ayant l'apparence des petits bâtonnets, disposés d'une maniére radiaire.

[2] When this paper was in press, 5 specimens of *P. genata* were sent to us from Palestine by Professor Witenberg. Careful examination of these specimens revealed that the position of the chitinous bars is true to his illustration.

the level of the ovary. In our specimen the ovary is transversely oval and the intestinal cæca reach as far as the anterior border of the testes.

ACKNOWLEDGMENT

We are greatly indebted to Prof. Ernest C. Faust, of Tulane University, and Prof. G. Witenberg, of the Hebrew University, for lending us some of their specimens for comparison, and to Dr. Candido M. Africa, Head of the Department of Parasitology, School of Hygiene and Public Health, University of the Philippines, for his kindness in going over this paper.

BIBLIOGRAPHY

CIUREA, I. Les vers parasites de l'homme, des mammiferes et des oiseaux provenant des poissons du Danube et de la mer Noire. Trematodes, famille Heterophyidae Odhner, avec un essai de classification des trematodes de la superfamille Heterophyoidea Faust. Arch. Roum. de Pathol. Exper. **6** Nos. 1 and 2 (1933) 64–67.

LINTON, E. Notes on the trematode parasites of birds. Proc. U. S. Nat. Mus. **73** (1928) 1–38.

LOOSS, A. Notizen zur Helminthologie Aegyptens. 7. Ueber einige neue Trematoden der aegyptischen Fauna. Centrabl. f. Bakteriol. **43** (1907) 478–490.

RANSOM, B. H. Synopsis of the trematode family Heterophyidae with descriptions of a new genus and a new species. Proc. U. S. Nat. Mus. **57** (1920) 527–573.

WITENBERG, G. Studies on the trematode family Heterophyidae. Ann. Trop. Med. and Parasit. **23** (1929) 184–187.

ILLUSTRATION

[Drawn by H. T. Rolda.]

[Abbreviations: *exb*, Excretory bladder; *int*, intestinal cæca; *lb*, lenticular-shaped body (gonotyl); *œs*, œsophagus; *os*, oral sucker; *ov*, ovary; *ph*, pharynx; *rs*, receptaculum seminis; *sv*, seminal vesicle; *t*, testis; *vg*, vitelline gland; *vgs*, ventrogenital sac.]

PLATE 1

FIG. 1. *Pygidiopsis marivillai* sp. nov., ventral view.

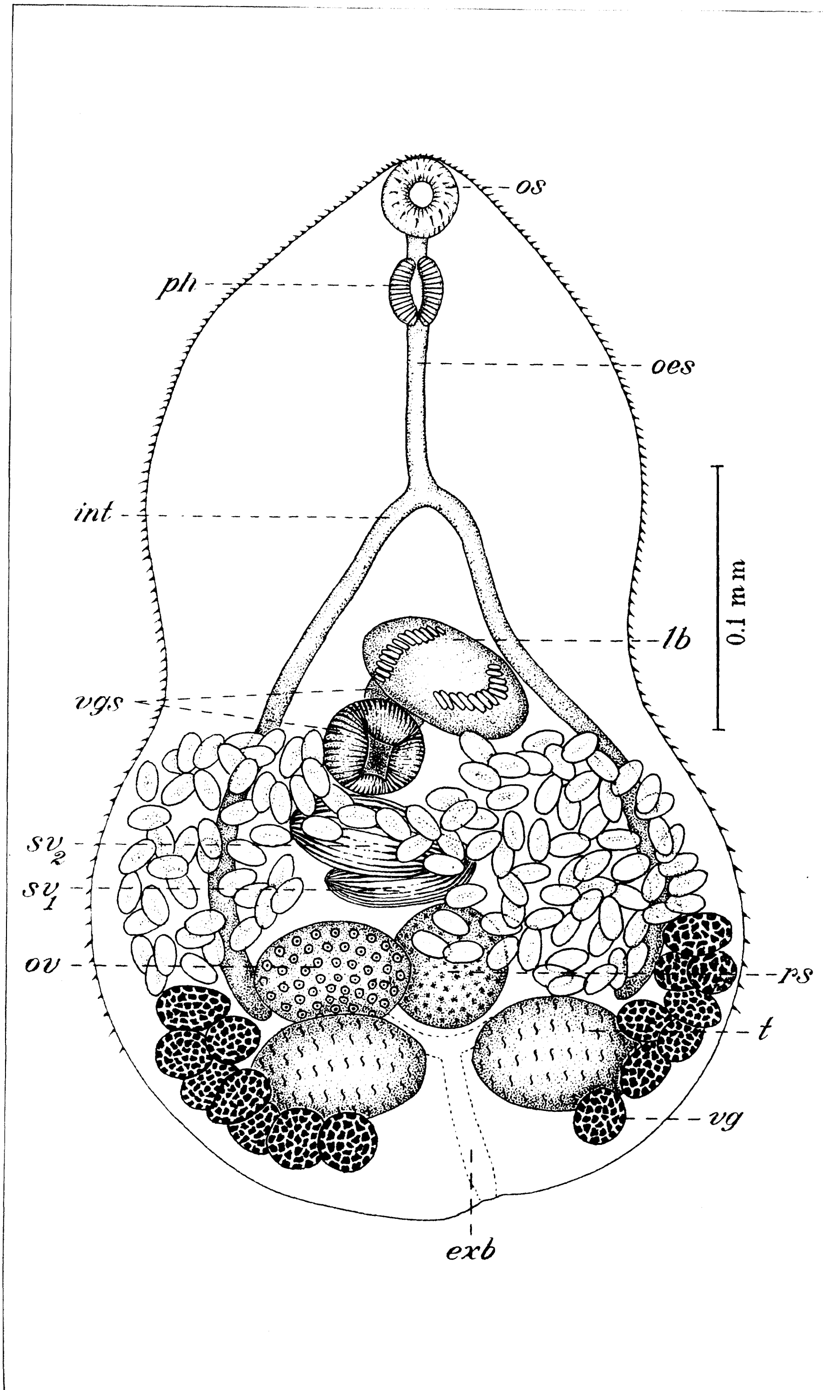

PLATE 1.

A MODIFIED PERMANGANATE METHOD FOR THE DETERMINATION OF ANTIMONY IN COMMERCIAL LEAD AND HIGH-LEAD ALLOYS

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The analysis of commercial lead or high-lead alloys for antimony is usually quite laborious and time consuming. The standard method of the American Society for Testing Materials requires large initial weights of the metal or alloy for analysis and involves the sulphide separation. Considerable experience is also required to carry out the method properly, because of the difficult procedures. Finally the antimony cannot be determined directly since it must be separated from the other metals present.

The distillation method first used by Fischer(1) for arsenic, and later extended to antimony and tin by other investigators [Plato,(2) Hartman,(3) Järvinen,(4) Biltz(5) and Sherrer(6)] has the attractive feature of being generally applicable to a wide range of ores and alloys containing antimony. This method requires an all-glass distilling apparatus which may not be always available in some laboratories.

The standard permanganate method for the determination of antimony is free from the sulphide objection and does not require a glass apparatus. Concerning the accuracy of this method Hillebrand and Lundell(7) state: "In the opinion of one of us (L) the most accurate determination of antimony, when its amount exceeds a few milligrams, is that in which the element is oxidized to the quinquevalent state in sulphuric-hydrochloric acid solution by means of a standard solution of permanganate." Besides the accuracy of this method it has the additional advantage that any tin present can be determined by the iodometric method in the residual solution from the antimony.

The procedure for the permanganate method is as follows: 1 gram of the metal or alloy is placed in a 500 cc Erlenmeyer flask and treated with 15 cc of concentrated sulphuric acid and 5 grams of potassium bisulphate. The flask is covered with

a small watch glass and its contents allowed to digest on a hot plate for one or two hours. The residue, after cooling, is mixed with 50 cc of 10 per cent tartaric acid and 10 cc of concentrated hydrochloric acid. The mixture is heated until it boils, and allowed to continue boiling for about a minute to eliminate sulphur dioxide. Then 125 cc of cold water is added, followed by 10 cc of concentrated hydrochloric acid. The mixture is cooled in ice to at least 10° C., and titrated with 0.1 *N* potassium permanganate to a slight pink shade that persists for about 10 seconds. This is essentially the method of Treadwell and Hall,(8) but slight changes have been made in the manner of dissolving the metal or alloy and also in the volumes of sulphuric and hydrochloric acids used. Hillebrand and Lundell limited their description of the method essentially to pointing out that the hydrochloric acid should be not less than 10 or greater than 25 per cent. The quantity of sulphuric acid they limit to approximately 10 per cent by volume.

This method has the additional advantage of being susceptible to considerable variation in manipulation.

In the analysis of alloys containing large amounts of lead (80 to 99 per cent) the permanganate method is not so accurate, due to the accumulation of relatively large quantities of insoluble lead sulphate formed during the conversion of the metals into sulphates. The insoluble lead sulphate naturally carries down or occludes a considerable amount of antimonious sulphate. During the subsequent operations only a part of the occluded antimony dissolves, so that in the final titration with potassium permanganate the results are likely to be low.

In view of this difficulty an experimental study was made with the object of treating the lead sulphate in such a manner that the occluded antimony can be restored to the solution, in order to correct any error from that source and to assure an accurate titration with standard permanganate.

EXPERIMENTAL PROCEDURE

Several experiments were carried out according to the suggested procedure of Hillebrand and Lundell. The residues containing the sulphuric acid, potassium bisulphate, and lead sulphate were digested with various quantities of water and hydrochloric acid. In one very carefully conducted experiment approximately 0.90 to 0.95 gram moist lead sulphate was mixed with 15 cc of sulphuric acid and 5 grams of potassium bisulphate.

The mixture was boiled a minute or two, cooled, and 15 cc of water added. It was again cooled, 15 cc of hydrochloric acid added, and the mixture digested hot for about 15 minutes. There was no appreciable solution of the lead sulphate. The volumes of water and hydrochloric acid were then increased by 25 cc and 10 cc of the two respectively. The hot digestion was repeated but the bulk of the lead sulphate remained undissolved. Finally 25 cc of water and 25 cc of hydrochloric acid were added and the hot digestion continued for about 15 minutes. At least a third of the lead sulphate remained undissolved. The percentage of hydrochloric acid in the final mixture would have been approximately 25 per cent, had the solution been diluted before titration, as in the permanganate method.

Duplicate determinations of antimony were next made in a sample of impure lead containing 94.43 and 5.45 per cent of lead and antimony respectively. The agreement of the duplicates was not good and the error ranged from 8 to 10 per cent. Evidently a portion of the antimony was still occluded in the lead sulphate.

Recently Robinson(9) developed a method for the determination of antimony in lead-rich alloys. He used no tartaric acid and appeared to depend entirely on the hydrochloric and sulphuric acids to dissolve the lead sulphate and to obtain the antimony in soluble form.

Determinations of antimony were made according to this method in two lead-rich mixtures. The first contained 0.9950 gram lead and 0.0050 gram antimony and the second 0.8950 gram lead, 0.0050 gram antimony, and 0.1000 gram tin. It was found that the lead sulphate was only partially dissolved and it was quite impossible to obtain any certain end points on account of the rapid fading-out effects.

It is well known that lead sulphate dissolves readily in a concentrated solution of ammonium acetate. It seemed quite probable that this salt might be used successfully to obtain all, or nearly all, of the antimony in titratable form.

Accordingly there were performed a number of experiments in which saturated ammonium acetate solution was used to dissolve the lead sulphate. In several analyses of metal mixtures containing 90 to 98 per cent of lead it was found that this change in the general procedure gave fairly good results. The average error in these preliminary experiments was usually about —3 per cent.

The permanganate method as modified and improved by the used of ammonium acetate is as follows:

MODIFIED PERMANGANATE METHOD

One gram of impure lead, or lead-rich alloy, is mixed with 15 cc of concentrated sulphuric acid and 5 grams of potassium bisulphate in a 500-cc Pyrex flask and allowed to digest on a hot plate overnight. The contents of the flask are then shaken and boiled for 10 to 12 seconds over a Bunsen flame. The insoluble sulphates should have no dark color. The flask and contents are allowed to cool and 15 cc of cold water are added slowly. The flask is then placed in an inclined position and the lead and other insoluble sulphates allowed to settle out rapidly. The transparent, or nearly transparent, liquid is then carefully decanted into a second Erlenmeyer flask, and the residual insoluble sulphates washed consecutively with two 25 cc portions of 10 per cent tartaric acid solution; the separate washings are decanted as before into the second flask, to which is added 10 cc of concentrated hydrochloric acid.

The washed and insoluble lead and other sulphates are then treated with 40 cc of 33 per cent ammonium acetate solution (Merck reagent), and digested, near the boiling point, on a hot plate until the insoluble sulphates completely dissolve. To obtain the proper volume 30 cc of water are now added and the solution set aside.

The washings in the second Erlenmeyer flask are then heated to the boiling point and the boiling continued for at least one minute. To the boiling solution 10 cc of hydrochloric acid are added, after which the contents of the first flask (the ammonium acetate solution of the lead and other insoluble sulphates) are rapidly added. The ammonium acetate flask is then washed with 40 cc of cold water. When this wash water is poured into the second flask it causes a portion of the lead sulphate to again precipitate. The final solution thus prepared is placed in ice and cooled to 5° or 8° C. It is then titrated in the usual manner with standard 0.1 *N* potassium permanganate. The end point should persist for 8 to 10 seconds and is usually easy to recognize.

Two acid burettes were used for the titrations. One was a 50-cc burette graduated at 27.5° C., and calibrated for measurements at 30° C. The other was a 10-cc microburette, which was also graduated at 27.5° C. It had been inspected and stamped in Berlin at the Physikalisch-Technische Reichsanstalt and could be read to 0.01 cc.

All titrations were carried out slowly and the readings were always made after the level of the solution in the burette was constant. A time interval of about 45 seconds was usually allowed for this adjustment.

The 0.1 *N* potassium permanganate was carefully standardized against 0.1500 gram of antimony and 0.1500 gram of tin under the same conditions as those employed in the modified method of analysis.

Six blank titrations were made according to the procedure above. The average value for the blank was 0.060 cc of the standard 0.1 *N* potassium-permanganate solution.

In Tables 1 and 2 are given the results of twenty-two analyses, made according to the modified permanganate method. Table 1 contains the analyses of various mixtures of lead and antimony, and analyses of mixtures containing lead, antimony, and tin are given in Table 2. The metals used for the analyses shown in Tables 1 and 2 and for the permanganate standardization above were Baker's C. P., analyzed.

TABLE 1.—*Analysis of mixtures of lead and antimony by the modified permanganate method.*

Sample.	Mixture.				Antimony.	
	Lead.		Antimony.		Found.	Error.
	g.	*Per cent.*	*g.*	*Per cent.*	*g*	*Per cent.*
1	0.9990	99.90	0.0010	0.10	0.00120	19.50
2	0.9980	99.80	0.0020	0.20	0.00192	— 4.10
3	0.9950	99.50	0.0050	0.50	0.00510	+ 2.00
4	0.9920	99.20	0.0080	0.80	0.00780	— 2.40
5	0.9500	95.00	0.0500	5.00	0.04908	— 1.80
6	1.9400	97.03	0.0600	2.97	0.05929	— 1.10
7	0.9500	95.00	0.0500	5.00	0.05035	+ 0.70
8	0.9000	90.00	0.1000	10.00	0.10003	+ 0.03

TABLE 2.—*Analysis of mixtures of lead, tin, and antimony by the modified permanganate method.*

Sample.	Mixture.						Antimony.	
	Lead.		Tin.		Antimony		Found.	Error.
	g.	*Per cent.*	*g.*	*Per cent.*	*g.*	*Per cent*	*g.*	*Per cent.*
1	0.9969	99.69	0.0014	0.14	0.00016	0.016	0.00035	+100.0
2	0.9985	99.85	0.0010	0.10	0.00050	0.050	0.00038	— 22.6
3	0.9891	98.91	0.0099	0.99	0.00102	0.102	0.00116	+ 13.6
4	0.9870	98.70	0.0111	1.11	0.00200	0.200	0.00198	— 1.2
5	0.9895	98.95	0.0085	0.85	0.00200	0.200	0.00197	— 1.2
6	0.9950	99.50	0.0010	0.10	0.00500	0.500	0.00496	— 0.8
7	0.9121	91.21	0.0799	7.99	0.00800	0.800	0.00805	+ 0.62
8	0.8000	80.00	0.1903	19.03	0.01000	1.000	0.00991	— 0.88
9	0.9000	90.00	0.0900	9.00	0.01000	1.000	0.00997	— 0.30
10	0.8850	98.50	0.1000	10.00	0.01500	1.500	0.00148	— 1.20
11	0.9396	93.96	0.0104	1.04	0.05000	5.000	0.00492	— 1.60
12	0.9094	90.94	0.0406	4.06	0.05000	5.000	0.00493	— 1.50
13	0.9000	90.00	0.0100	1.00	0.09000	9.000	0.09032	+ 0.35
14	0.8000	80.00	0.0100	1.00	0.19000	19.000	0.19050	+ 0.26

SUMMARY

Analyses of lead-antimony and of lead-tin-antimony mixtures were made by the permanganate method as modified by the use of ammonium acetate.

The modified method is easily carried out and amounts of antimony from 0.20 to 19.00 per cent in high lead alloys can be successfully determined with an accuracy ranging from about 0.30 to 2.0 per cent.

The presence of tin up to 19 per cent exerts no objectionable influence on the accurate determination of the antimony in high lead alloys.

When less than 0.2 per cent of antimony is present the accuracy is greatly reduced and the modified permanganate method becomes impractical for such amounts, as shown in samples 1 (Table 1) and 1, 2, and 3 (Table 2).

The use of hydrochloric acid as a means of rendering the lead sulphate soluble and thus obtaining the occluded antimony in titratable form was found to be undesirable for the high-lead antimony and tin mixtures investigated.

Compared to the distillation method and also to the standard method, the modified permanganate method is much more direct, less laborious, and should not require more than 90 minutes after the metals have been converted to sulphates.

A microburette graduated to 0.01 cc is very necessary for the accurate analysis of lead samples that have an antimony content of 0.20 to 6 per cent.

The residue from the antimony analysis can be used conveniently for the determination of tin by the volumetric method.

REFERENCES

1. FISCHER, EMIL. Scheidung und Bestimmung des Arsen. Ber. Deut. Chem. Ges. **13** (1880) 1778; Liebig's Ann. **208** (1881) 182.
2. PLATO, W. Antimon und Zinntrennung durch Distillation. Zeit. Anorg. Chem. **68** (1910) 26.
3. HARTMAN. Journ. Anal. Chem. **58** (1919) 148.
4. JÄRVINEN, K. K. Zur Bestimmung und Trennung des Arsen, Antimon und Zinn. Zeit. Anal. Chem. **62** (1923) 192.
5. BILTZ, HEINRICH. Bestimmung von Arsen, Antimon und Zinn. Zeit. Anal. Chem. **81** (1930) 82.
6. SHERRER, JOHN A. Distillation and separation of arsenic, antimony and tin. Journ. Res. **16** (1936) 305.
7. HILLEBRAND, W. F., and G. E. F. LUNDELL. Applied Inorganic Analysis (1929) 227.
8. TREADWELL, F. P., and W. T. HALL. Analytical Chemistry **2** (1930) 194a.
9. ROBINSON, R. G. Determination of antimony in lead-rich alloys. Analyst **62** (1937) 191.

THE OXYBELINE WASPS OF THE PHILIPPINES, WITH A SYNONYMIC CATALOGUE OF THE ORIENTAL SPECIES (HYMENOPTERA: SPHECIDÆ)

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ONE PLATE

The oxybeline wasps of the Philippines have attracted little attention hitherto, and save for a very inaccurate and incomplete description of a species by Ashmead, nothing has been published on the group from this region. The present paper is based upon the large Philippine collection, now in the United States National Museum, formed by the late Charles Fuller Baker, of the College of Agriculture (Philippines), and smaller ones made by Dr. Francis X. Williams, of the Hawaiian Sugar Planters' Association, and the late R. C. McGregor, of the Philippine Bureau of Science. Further collecting in the interior of the islands and in northern Luzon, regions from which material is still lacking, will probably result in the addition of new forms to the Philippine fauna. Until such material is forthcoming, the keys presented in this paper will serve to place all forms known at present to occur in this region.

The Philippines and Wallacea [1] in general have a very poor representation of oxybelines, in comparison with the other regions of the world, with the exception of Australia and the Polynesian region. Only eight forms [2] are known from this area, and all of these belong to the wide-ranging genus *Oxybelus*. *Belomicrus* and *Belomicroides* are still unknown from the Philippines, or for that matter from Wallacea and the adjacent Malayan region. These genera, however, are more ancient types than *Oxybelus*. They are largely Holarctic and Æthiopian in distribution, and in these regions are, in the main, confined to definitely more xeric areas than *Oxybelus;* consequently, it is

[1] See Dickerson et al.: Distribution of Life in the Philippines, Monographs of Bureau of Science, Manila, No. 21, for a definition and discussion of this region.

[2] Including *Oxybelus agile* Smith, recorded from Celebes.

hardly likely that they will be found in Wallacea, which has in large part an extremely heavy rainfall. I have seen no material of this group in general from northern Luzon, so that it is barely possible that in the drier portions of northern and western Luzon there may eventually be found a relic form that is the survivor of some early faunal invasion.

The pauperitic character of the oxybeline fauna in the Philippines and in Wallacea in general is due to the fact that the group is ectogenic to the Oriental region. It is entirely absent from the Australian region, and but one species [3] is as yet known from the Polynesian region. Such species as now occur in the Orient are representatives of, or developments from, relatively recent colonizations from the Palæartic region. The oxybeline population of Wallacea and the Malayan region to the west of it are relatively recent invasions from the Indian region, although in the case of Malaysia there has been a noticeable influx from China. The forms now occurring in Wallacea are representatives of the *agile* and the *lamellatum* groups. The former is widely distributed throughout the Orient, while the latter is widespread over the Oriental, Æthiopian, and Mediterranean regions. The *agile* group is represented in the Philippines by *Oxybelus suluense* and *O. xanthogaster*, and is confined entirely to the Bornean province, whereas the *lamellatum* group,[4] a more highly developed assemblage in many respects than the former, is restricted almost exclusively to the Philippine provinces, where certain species such as *Oxybelus banksi* and *O. philippinense* are widely distributed throughout the islands.

As yet nothing is known concerning the ethology of the Philippine oxybelines; but, as in other regions of the world, they in all probability provision their nests with flies, particularly such common domiciliary or semidomiciliary pests as the house fly, the blue bottle, the stable fly, and many others of more or less economic importance. Fletcher [5] states that at Coimbatore and Guindy, in southern India, *Oxybelus lamellatum* Olivier [6] is a very

[3] *Oxybelus uturoæ* Cheesman, described from Raiatea in the Society Islands.

[4] This is the group to which Dahlbom's name *Notoglossa* is applicable. Many authors have considered it a discrete genus, incorrectly placing therein all the species of *Oxybelus* that have the apex of the mucro excised. *Notoglossa*, however, is at most but a species group and is confined entirely to the Old World.

[5] Some South Indian Insects (1914) 280.

[6] Recorded as *Oxybelus squamosus* Smith, 1875, a synonym of *O. lamellatum* Olivier, 1811.

efficient and useful check on *Musca crassirostris* Stein,[7] a common blood-sucking fly of cattle of that region. Both Laveran[8] and Piccard[9] have recorded *Oxybelus rufipes* Taschenberg preying upon tsetse flies in considerable numbers in tropical Africa, while recently Bequaert[10] has called attention to the fact that in Guatemala *Oxybelus pyrura* (Rohwer), known by the natives as "policias," is a very efficient enemy of adult *Simulium* and preys commonly there upon the three species[11] that are the vectors of onchocerciasis. The species of this genus, therefore, fill a useful niche, however small it may be, in the natural control of many noxious pests, and more data are greatly to be desired concerning the habits and prey of the tropical species.

Key to the genera of Oxybelinæ.

1. Postscutellum simple, not provided laterally with squamæ; propodeum simple, not furnished with a median dorsal process—the mucro; last abdominal sternite of the female strongly compressed and provided with a high median longitudinal lamelliform carina; abdomen of the male with transverse villous grooves near bases of third and fourth tergites; psammophore present, well developed in the female, vestigial or rudimentary in the male. Æthiopian and Mediterranean forms. *Belomicroides* Kohl.

   Postscutellum armed laterally with squamæ, or at least with alate lateral expansions; propodeum (except in *Anoxybelus* Kohl) with a mucro; abdomen not as above .... 2.

2. Abdominal tergites 1 to 5 (and 6 in males) abruptly flexed under at sides so that ventral and dorsal portions of tergites form a sharp edge at their junction; sternites flat; appendiculate cell of forewing, if present, very small, so that marginal cell appears lanceolate or acute at apex; last tarsal joint not swollen; female with a psammophore. Widespread .... *Belomicrus* A. Costa.

   a. Flagellum of antennæ short, all joints, except first, second, and last as wide as or wider than long; mandibles edentate internally or with only a dentiform angle medially .... *b.*

   Flagellum long, first six and apical joints longer than wide, remainder as long as wide; mandibles with a very large tooth internally near base, outer margin dilated above at about middle, basal third arcuately excised. South African forms. *Belomicrus* (*Nototis*) Arnold.

[7] Recorded as *Philæmatomyia insignis* Austen, a synonym of *Musca crassirostris* Stein.

[8] Comp. rend. Acad. Sci. 144 (1907) 546–551.

[9] Comp. rend. Mem. Soc. Biol. 61 (2) (1909) 360–362.

[10] Contrib. Dept. Trop. Med. & Inst. Trop. Biol. & Med. Harvard (6) (1934) 201–202.

[11] *Simulium metallicum* (Dyar et Shannon), *S. callidum* Bellardi, and *S. ochraceum* Walker.

b. Mandibles excised on their outer margin.
Belomicrus (*Oxybelomorpha*) Brauns.[12]

Mandibles entire, not excised beneath.
Belomicrus (*Belomicrus*) A. Costa.

Tergites not sharply fixed under at sides, sharp edge not present save on first two tergites; sternites convex; females without a distinct psammophore .... 3.

3. Last tarsal segment not swollen; appendiculate cell of forewing, if present, very small so that marginal cell appears lanceolate or acute at apex; postscutellar squamæ poorly developed, merely alate lateral expansions of postscutellum; no distinct tarsal comb present. South African forms .... *Brimocelus* Arnold.

   Last tarsal segment swollen; appendiculate cell of forewing distinct and wide so that marginal cell appears more or less truncate apically; squamæ always distinct and well developed; tarsal comb present and well developed; at least in the female .... 4.

4. Mesepisternum with a precoxal carina; scutellum and postscutellum longitudinally carinate medially; puncturation of body usually coarse. Widespread .... *Oxybelus* Latreille.[13]

   Mesepisternum without a precoxal carina; scutellum and postscutellum not longitudinally carinate medially; puncturation of body finer. Nearctic forms .... *Enchemicrum* Pate.

Genus OXYBELUS Latreille[14]

Key to the Philippine species.

1. Males .... 2.

   Females .... 5.

2. Mucro narrow, canaliculate above, sides subparallel, apex retuse (Plate 1, fig. 1); lateral abdominal spines absent .... *suluense* sp. nov.

   Mucro subfoliaceous, apex excised, with a median longitudinal carina; lateral abdominal spines present .... 3.

3. Mesonotum with large punctures evenly distributed throughout, not depressed but flat or convex discally between parapsides.
æquipunctatum sp. nov.

   Mesonotum coarsely and confluently punctured, rugose posteriorly, depressed and more or less excavate discally between parapsides .... 4.

[12] Gussakovsky recently proposed *Pseudoxybelus* [Trav. Inst. Zool. Acad. Sci. URSS 1 (1933) 266] as a subgenus of *Belomicrus* for the reception of *B. persa* Guss. from Kirman, Persia. *Pseudoxybelus*, however, may at most be regarded as but a species-group of the subgenus *Oxybelomorpha* Brauns.

[13] Including *Anoxybelus*, which Kohl proposed as a subgenus [Konowia 2 (1923) 274] of *Oxybelus* for the reception of *O. maidlii* Kohl from Abu in Baluchistan. I have not seen any material of this species, still known only from the unique female type in the British Museum. Insofar as I can gather from Kohl's description, *Anoxybelus* differs from the typical *Oxybela* only in lacking a mucro.

[14] The gender of *Oxybelus* has hitherto been regarded as masculine, but a study of its etymology at once reveals that it is neuter.

4. **Mucro traversed from base to apex of excision by a very strong median longitudinal carina whence diverge on each side a number of transverse oblique carinulæ (Plate 1, fig. 2) .... *banksi* (Ashmead).**
   Mucro with a weak median longitudinal carina forking about half way and sending a weak oblique carina toward each tip of mucro (Plate 1, fig. 3) .... *banksi* forma *divaricatum* fo. nov.
5. Mucro narrow, canaliculate above, sides subparallel, apex retuse or emarginate (Plate 1, figs. 4 and 6) .... 6.
   Mucro foliaceous, excised at apex and with numerous longitudinal and oblique carinulæ (Plate 1, fig. 11) .... 7.
6. Clypeal bevel sharply and obtusely angulate medially (Plate 1, fig. 7); temporal carinæ obsolete below; first two abdominal tergites at most with large yellow maculæ laterally .... *suluense* sp. nov.
   Clypeal bevel rounded out medially (Plate 1, fig. 9); temporal carinæ present below; abdominal tergites 2 to 5 entirely yellow above. *xanthogaster* sp. nov.
7. Median fovea of propodeum shining, impunctate within. *philippinense* sp. nov.
   Median fovea of propodeum dull, reticulate within. *philippinense* forma *reticulatum* fo. *nov.*

OXYBELUS SULUENSE sp. nov. Plate 1, figs. 1, 4, 7, and 8.

Male.—Length 4.5 millimeters. Black; mandibles yellow, apices dark red; pronotum to and including tubercles, spot on tegulæ, a large spot on each side of scutellum, squamæ internally, middle third of mucro, apical half of fore and middle femora beneath, hind femora apically above, fore and middle tibiæ externally, hind tibiæ basally, yellow. First abdominal tergite with large, well separated yellow spots laterally; second, third, and fourth tergites with traces of linear maculations laterally. Tegulæ, squamæ, and apical third of mucro, whitish subhyaline. Wings clear hyaline, veins dark brown. Front and clypeus with silvery pubescence, somewhat appressed; thorax and abdomen with thin, scattered silvery pubescence.

Head with small close punctures; vertex and temples striate-punctate; clypeus strongly carinate medially, anterior margin sharply tridentate, median tooth rostrate, formed by projecting end of discal carina (Plate 1, fig. 8); temporal carina present above, obsolete or obsolescent below.

Thorax with puncturation similar to head; anterior margin of pronotum transversely carinate to and including tubercles which are subdentate laterally. Mesonotum with a median longitudinal stria on anterior third, and a carina on posterior sixth. Scutellum and postscutellum longitudinally carinate medially, punctured like the mesonotum. Squamæ subrectangular, internally with a blunt tooth that barely surpasses incurved, acute, depressed apices (Plate 1, fig. 1). Prepectus and mesosternum

sharply margined anteriorly; episternal suture foveolate; prepectus and pleura rugose. Mucro narrow, straight, canaliculate above, sides subparallel, apex retuse (Plate 1, fig. 1). Propodeum with oblique rugæ and reticulations dorsally; median fovea subrectangular, ventrally with an acute angle passing into a median carina as long as fovea which is polished and impunctate within and incompletely closed above; lateral areas shining, with a few fine, scattered punctures and transverse rugæ; lateral faces shining, with a few longitudinal striæ.

Abdomen shining, with fine, well separated punctures, preapical color-ridges moderately developed; lateral abdominal spines wanting; pygidium rectangular, wider than long; sternites polished, with a few fine, scattered punctures.

Female.—Length 5 millimeters. Differs from male as follows: Maculations of scutellum and abdomen larger. Mucro emarginate apically (Plate 1, fig. 4), and with basal two-thirds and adjacent region of propodeum yellow. Clypeus (Plate 1, fig. 7) tuberculate discally, subbevelate, polished and impunctate apically where it is quadrisinuate and thus tridentate, apical margin acutely pointed medially. Temporal carina weak, obsolete below.

Holotype.—Male, BORNEO, Sandakan (*Baker*), United States National Museum, catalogue No. 42747.

Allotype.—BORNEO, 1 female, Sandakan (*Baker*), United States National Museum, catalogue No. 42747.

Paratypes.—BORNEO, 2 males, Sandakan (*Baker*), United States National Museum. PALAWAN, 1 male, Puerto Princesa (*Baker*), United States National Museum.

This species, a member of the *agile* group, is closely related to *O. agile* Smith, from which it may, however, be readily differentiated by the structure of the mucro and the squamæ and by the somewhat different color pattern. It is confined entirely to Borneo, like the following species.

OXYBELUS XANTHOGASTER sp. nov. Plate 1, figs. 6 and 9.

Male.—Unknown.

Female.—Length, 5 millimeters. Black; mandibles yellow, apices dark red; pronotum to and including tubercles, a spot on each side of scutellum, postscutellum laterally and posteriorly, and inner margins of the squamæ, mucro basally and medially, posterior half of the first abdominal tergite and all of second to fifth tergites, fore and middle femora apically beneath, all tibiæ basally above, whitish yellow. Fore tibiæ and all tarsi,

fusco-ferrugineous; propodeum fuscous to fusco-piceous; antennæ fulvescent apically. Face and pleura with short, rather sparse, somewhat appressed pubescence; vertex and mesonotum with short, erect aëneous pubescence.

Head shining, with fine close puncturation; front with two shining, impunctate impressions to accommodate scapes when laid back; clypeus (Plate 1, fig. 9) sharply tuberculate discally just below antennal line, nitidous, subbevelate and quadrisinuate apically, evenly rounded out medio-apically; temporal carinæ present and well developed above and below.

Thorax with puncturation coarser than that of head. Pronotum transversely carinate anteriorly to and including tubercles which are subdentate laterally. Squamæ and mucro as in *suluense* save that the latter in this species is distinctly emarginate. Pleura coarsely punctate but not as strongly so as in *suluense.* Propodeum shining, with transverse oblique parallel carinulæ dorsally; median fovea broadly cuneate in outline, open above, shining within; lateral areas shining and with a few weak transverse somewhat irregular rugulæ; lateral faces nitidous, dorsally and posteriorly with a few fine rugulæ.

Abdomen cordate, subopaque to almost shining, with fine close puncturation on the tergites; sternites shining, polished, and with a few scattered punctures.

Holotype.—BORNEO, Lebang Hara, January 7, 1925 [15] (*H. Winkler*), Zoologisches Museum, Hamburg, Germany.

This species, like the preceding one, belongs to the *agile* group. It is very close to *suluense* but the structure of the clypeus, the well-developed temporal carinæ, and the strikingly colored abdomen, stamp it as a discrete species. I am greatly indebted to Herr Wagner, of the Zoologisches Museum of Hamburg, for the opportunity of studying this interesting species.

OXYBELUS BANKSI (Ashmead). Plate 1, figs. 2 and 10.

Notoglossa banksi ASHMEAD, Proc. U. S. Nat. Mus. 28 (1905) 960; female.

Notoglossa banksi BROWN, Philip. Journ. Sci. 1 (1906) 686.

Male.—Length, 4.5 millimeters. Black; mandibles yellow, apices red; scapes and sometimes flagellum, prothoracic tubercles, squamæ internally, fore and middle femora apically beneath, all tibiæ externally, and tarsi, whitish yellow. First and second abdominal tergites with narrow elongate maculations laterally. Tegulæ and squamæ whitish subhyaline, margins and posterior

[15] The date on the label of this specimen is given as "7.1.1925."

third of mucro piceous subhyaline. Wings clear hyaline, veins dark brown. Front and clypeus clothed with silvery pubescence, somewhat appressed; thorax, abdomen, and legs sparsely clothed with silvery white hairs.

Head with small semiconfluent punctures which are larger and further apart just below ocelli; vertex very closely punctured; occiput and temples striate-punctate. Clypeus tridentate, median tooth strongly rostrate, apically with an inflexed nitidous impunctate bevel which is quinquedentate apically (Plate 1, fig. 10). Temporal carina well developed.

Thorax with anterior margin of pronotum transversely and sharply carinate, notched medially; mesonotum finely punctate anteriorly, coarsely punctate and rugose posteriorly, foveolate along posterior margin, depressed and more or less sulcate discally between parapsides, with a longitudinal stria anteriorly and a short low longitudinal carina mesoposteriorly. Scutellum coarsely punctate, with a median longitudinal carina; postscutellum finely punctate, with a median longitudinal cristate lamelloid carina. Squamæ subtrigonal, external margins raised, internally with an acute lobe that slightly surpasses incurved, acute, depressed apex. Prepectus and mesosternum sharply margined anteriorly; pleura coarsely punctate-striate. Mucro subfoliaceous (Plate 1, fig 2), lateral margins only slightly raised, as long as scutellum and postscutellum, widest at about basal third, thence very slightly narrowed toward apex which is angularly and deeply excised; traversed from base to apex of excision by a very strong longitudinal crista whence diverge on each side a number of transverse oblique carinulæ. Propodeum with oblique rugæ and reticulations dorsally; median fovea cuneate, shining and impunctate or occasionally finely granulose within, more or less closed above; lateral areas sparsely and very finely punctured, with a few transverse rugæ above, nonstriate below; lateral faces sparsely and very finely punctate, longitudinally striate.

Abdomen shining, punctures of the first two tergites coarser than those of succeeding tergites; preapical color-ridges present and well developed on tergites 1 to 4; 3 to 6 with small acute spines latero-apically on each side, 6 with a dorsolateral carinula on each side terminating posteriorly in a small spine; pygidium rectangular, longer than broad. Sternites shining, highly polished, sparsely punctate; second sternite finer and more closely punctate laterally.

Female.—Unknown.

Holotype.—Male, LUZON, Manila (*Charles S. Banks*), United States National Museum, catalogue No. 8201.

LUZON, Manila, 4 males, October, 1918 (*R. C. McGregor*), Cornell University; 2 males, no date (*Robert Brown*), United States National Museum: Laguna Province, Mount Maquiling, 2 males, no date (*Baker*), United States National Museum; Los Baños, 1 male, July 16 (*Frederick Muir*), Williams collection; 2 males, no date (*Baker*), United States National Museum. MINDORO, 1 male, December, 1921 (*F. X. Williams*), Williams collection. SIBUYAN, 2 males, no date (*Baker*), United States National Museum. SAMAR, 8 males, no date (*Baker*), United States National Museum. LEYTE, Tacloban, 3 males, no date (*Baker*), United States National Museum. CEBU, Cebu, 2 males, April, 1917 (*F. X. Williams*), Williams collection. NEGROS, Occidental Negros Province, 1 male, April, 1917 (*F. X. Williams*), Williams collection; Cuernos Mountains, 1 male, no date (*Baker*), United States National Museum. MINDANAO, Dapitan, 8 males, no date (*Baker*), United States National Museum; Davao, 1 male, no date (*Baker*), United States National Museum; Kolambugan, 25 males, no date (*Baker*), United States National Museum; Surigao, 1 male, no date (*Baker*), United States National Museum; Tangcolan, 1 male, no date (*Baker*), United States National Museum. PALAWAN, Puerto Princesa, 8 males, no date (*Baker*), United States National Museum.

Ashmead's description of this species is so inadequate and incorrect that it has been necessary to redescribe it. In his original description he states that the specimen he had before him was a female, but an examination of the type in the United States National Museum has revealed that it is a male. Ashmead furthermore states that *banksi* resembles *Notoglossa emarginata* (Say), but the latter belongs to an entirely different species-group from the former.

In the large series of specimens of *banksi* before me, there is considerable variation in the color pattern, ranging from relatively xanthic forms with the color distributed as noted in the foregoing description to melanistic specimens lacking any abdominal or thoracic maculations whatever. It might be possible to attribute these various color phases to seasonal and environmental factors, were there but full data available regarding the time, place, and conditions under which the material, particularly that collected by the late C. F. Baker, was taken. In addi-

tion to the variation in color, there is likewise a certain amount of variation in the sculpturing of the mucro and the puncturation and relative degree of sulcation of the mesonotum. However, these departures from the norm of the species are, as a rule, in no wise linked, but all conform in general to a common pattern.

OXYBELUS BANKSI forma DIVARICATUM fo. nov. Plate 1, fig. 3.

Male.—Length 4.5 millimeters. Differs from *banksi* as follows: Mucro (Plate 1, fig. 3) trigonal, sides more strongly divergent, apex excised, with a weak longitudinal carina forking about half way and sending a weak carina to each mucronal tip. Mesonotum rugose. Abdomen black, without maculations.

Female.—Unknown.

Holotype.—Male, MINDANAO, Kolambugan (*Baker*), United States National Museum, catalogue No. 42748.

This form has the general habitus of *banksi,* which likewise occurs at Kolambugan, as well as throughout the island of Mindanao. The mucro, however, as may be readily seen by consulting Plate 1, fig. 3, is quite distinct in shape and sculpturing from that of the typical *banksi.* It is quite possible that with the accession of more material *divaricatum* may be elevated to the rank of a discrete species. Until further material is forthcoming, however, it seems best at present to regard it as merely an atypical form.

OXYBELUS ÆQUIPUNCTATUM sp. nov. Plate 1, fig. 12.

Male.—Length, 5.5 millimeters. Black; mandibles yellow, apices dark red; scape dark brown, yellow apically, flagellum fulvescent apically. Pronotum to and including tubercles, a spot on tegulæ, squamæ internally, fore and middle femora apically beneath, fore, middle, and hind tibiæ and tarsi yellow; tarsi fulvescent apically. First abdominal tergite with narrow, linear, widely separated yellow maculations laterally; second, third, and fourth tergites with linear, widely separated yellow maculations laterally present only as a trace. Front and clypeus clothed with silvery pubescence; mesonotum with scattered fulvo-aëneous pubescence; pleura with short, scattered, whitish pubescence.

Head with front more closely punctate than *banksi,* puncturation uniform throughout; vertex and occiput very strongly and coarsely punctured; clypeus quite similar to *banksi,* with a strong median longitudinal carina discally, tridentate, the middle tooth strongly rostrate, apically with an inflexed nitidous bevel which is quinquedentate; temporal carinæ well developed throughout.

Thorax with the anterior margin of the pronotum sharply and transversely carinate, notched medially, laterally subdentate; mesonotum and scutellum nigro-aëneous, with large well-separated punctures throughout, their posterior margins foveolate; postscutellum medially with a longitudinal cristate lamelloid carina; squamæ subtrigonal, internally with an acute dentoid lobe that surpasses posteriorly the incurved, acute, depressed apex. Prepectus and mesosternum sharply margined anteriorly; pleura coarsely punctate. Mucro (Plate 1, fig. 12) subfoliaceous, the lateral margins only slightly raised, as long as scutellum and postscutellum, widest at about middle, thence subparallel to apex which is angularly and deeply excised, traversed from base to apex of excision by a very strong median longitudinal carina whence diverge on each side several transverse oblique carinulæ. Propodeum with oblique reticulations dorsally; median fovea trigonal, acuminate ventrally and passing there into a very short median carina, polished and impunctate within, open above; lateral areas finely and sparsely punctured, with a few irregular rugæ above; lateral faces shining, with fine scattered punctures between the longitudinal rugæ; lateral carinæ simple, not forked below.

Abdomen shining, rather coarsely punctate, preapical color-ridges present and well developed on first four tergites; third to sixth tergites with small acute spines latero-apically; pygidium rectangular, longer than broad; sternites shining, highly polished, and with a few scattered punctures.

Female.—Unknown.

Holotype.—Male, LUZON, Mount Maquiling (*Baker*), United States National Museum, catalogue No. 42749.

This species is very closely allied to *banksi* but may be readily distinguished from it by the evenly punctured and nonsulcate mesonotum.

OXYBELUS PHILIPPINENSE sp. nov. Plate 1, figs. 5 and 11.

Male.—Unknown.

Female.—Length, 6.25 millimeters. Black; mandibles yellow, apices red; scapes yellow with a dark-brown spot internally, flagellum fulvescent apically. Pronotum, tubercles, a spot laterally on each side of scutellum, postscutellum and squamæ internally, fore and middle femora apically beneath, fore tibiæ externally, and middle and hind tibiæ basally, yellow. Tarsi and fore tibiæ fulvous beneath. First four abdominal tergites

laterally with transverse elongate maculations. Tegulæ and squamæ with outer margins subhyaline; margins of mucro piceous subhyaline. Head sparsely clothed with short silvery pubescence; mesonotum with short fulvo-aëneous hairs; pleura with short scattered whitish pubescence.

Head with small semiconfluent punctures which are larger and farther apart just below the ocelli; vertex coarsely punctured; occiput and temples finely striate-punctate; clypeus (Plate 1, fig. 5) tuberculate discally, subbevelate, shining and impunctate apically, rounded out medio-apically, obscurely bidentate laterally; temporal and occipital carinæ present and well developed.

Thorax with the anterior margin of pronotum sharply and transversely carinate, notched medially, subdentate laterally; mesonotum and scutellum shining, with large well-separated punctures, foveolate along their posterior margins; scutellum and postscutellum carinate longitudinally in middle, carina of latter lamelloid; squamæ short, subtrigonal, internally with an acute lobe which slightly surpasses the incurved, acute, depressed apices; prepectus and mesosternum sharply margined anteriorly; mesopleura shining, with large, well-separated punctures; metapleura longitudinally striate. Mucro (Plate 1, fig. 11) subovate, horizontal except at base, widest at about basal third, carinate longitudinally in middle with several subparallel to oblique carinulæ on each side, apex with an acute angular excision, apical teeth rounded. Propodeum with oblique rugæ and reticulations dorsally; median fovea cuneate, acuminate ventrally and passing thence into a short median carina, shining and impunctate within, open above; lateral areas shining, sparsely and very finely punctate; lateral carinæ simple, not forked below; lateral faces shining, sparsely and very finely punctate, finely longitudinally striate above.

Abdomen shining, with small well-separated punctures, those of the first two tergites coarser than those of following segments; preapical color-ridges present and well developed laterally on the first four tergites; pygidium trigonal, with short, coarse, appressed azureous hairs; sternites shining, highly polished, with a few distinct, scattered punctures basally, impunctate apically.

Holotype.—Female, LUZON, Los Baños, altitude 60 meters, November 12, 1932 (*Felix J. Madrid*).

Paratypes.—LUZON, Laguna Province, Los Baños, 2 females, no date (*Baker*), United States National Museum. MINDANAO, Kolambugan, 1 female, no date (*Baker*), United States National Museum; Dapitan, 1 female, no date (*Baker*), United States National Museum; Surigao, 1 female, no date (*Baker*), United States National Museum; Zamboanga, 1 female, September, 1921 (*F. X. Williams*), Williams collection. SAMAR, 2 females, no date (*Baker*), United States National Museum. BILIRAN, 1 female, no date (*Baker*), United States National Museum. NEGROS, Occidental Negros Province, 2 females, September, 1921 (*F. X. Williams*), Williams collection; Dumaguete, 1 female, April, 1917 (*F. X. Williams*), Williams collection. LEYTE, Tacloban, 1 female, no date (*Baker*), United States National Museum.

This species may eventually prove to be the female of *O. banksi*, but the great difference in the sculpturing of the thorax, particularly of the mesonotum, and in the character of the mucro and squamæ, have led me to regard it as discrete. Its thoracic structure approximates that of *O. æquipunctatum*, so that when fuller data are at hand, *philippinense* may prove to be the female of that form. *O. philippinense* is very interesting because its mucro exhibits a transition stage from the subfoliaceous type, such as is found in *O. banksi* (Ashmead), or in the New World *O. sparideum* (Cockerell) and the highly developed lamello-foliaceous type of the *O. lamellatum* subgenus for which Dahlbom erected the genus *Notoglossa*. Its affinities, however, are definitely with the latter rather than the former group. The livery of *philippinense* varies in a fashion comparable to, but not as greatly as, that of *banksi*.

OXYBELUS PHILIPPINENSE forma RETICULATUM fo. nov.

Female.—Length, 6 millimeters. Similar to *philippinense* but differing from it in having the median fovea of the propodeum dull and reticulate within, the maculations of the scutellum larger, and the postscutellum black medially.

Male.—Unknown.

Holotype.—Female, MINDANAO, Kolambugan (*Baker*), United States National Museum, catalogue No. 42750.

Paratype.—SAMAR ISLAND, female (*Baker*), United States National Museum.

In the series of specimens of *philippinense*, two were found which differed from the typical pattern of the species by the characters given above and which have led me to regard them as

atypical forms that may be worthy of recognition. These may eventually prove to be merely aberrant individual specimens.

A SYNONYMIC CATALOGUE OF THE OXYBELINE WASPS OF THE ORIENTAL REGION

Since the appearance in 1897 of the eighth volume of Dalla Torre's Catalogus Hymenopterorum, no less than twenty-four Oriental species of *Oxybelus* and related genera have been described. With the accession of more material since the publication of the first volume of the Hymenoptera in the Fauna of British India and critical studies of typical specimens, it has been necessary to synonymize a number of species formerly considered valid. These data scattered throughout the literature of forty years have been brought together and are offered here in the form of a synonymical species catalogue so that they may be readily accessible to the students of the Oriental fauna. Further material from Siam, Burma, and the East Indies will unquestionably extend the known range of many of these forms and, in addition, undoubtedly lead to the discovery of new ones. It will indubitably result in making it necessary to consider as synonyms several of the species still considered valid.

As yet but one species of *Belomicrus* has been recorded from the Oriental region. *Belomicroides* has not yet been recorded from the Orient, while *Brimocelus* and *Enchemicrum* are still monotypic genera, the former known only from Rhodesia and the latter from the Austroriparian zone of the United States. In 1922 Kohl described *Oxybelus maidlii* for which, owing to the poor development of the squamæ and the absence of a mucro, he erected the subgenus *Anoxybelus* in the genus *Oxybelus*. I have followed Kohl in the catalogue below with regard to this species, having seen no authentic material of this species, which is still known only from the unique type in the British Museum. It may eventually prove to be either a *Brimocelus*, or more probably, a teratologic form of a species of *Oxybelus*, since forms of the latter are occasionally taken in which the mucro or squamæ or both are aborted or even entirely absent.

Genus BELOMICRUS A. Costa

Belomicrus A. COSTA, Ann. Mus. Zoöl., Univ. Napoli 6 (1871) 80.

Oxybeloides RADOSZKOWSKI, Fedtschenko, Reise in Turkestan II, Sphegid. (1877) 68.

Oxybelomorpha BRAUNS, Kohl, Ann. k. k. Naturhist. Hofmus. Wien 11 (1896) 475.

Nototis ARNOLD, Ann. Transvaal Mus. 12 (1927) 64.
Pseudoxybelus GUSSAKOVSKIJ, Trav. Inst. Zoöl. Acad. Sci. URSS 1 (1933) 266.

Subgenus BELOMICRUS (sensu strictu)

BELOMICRUS (BELOMICRUS) MEYERI Kohl.

Belomicrus meyeri KOHL, Konowia 2 (1923) 260; male, BALUCHISTAN, Quetta.

Genus OXYBELUS Latreille

Oxybelus LATREILLE,[16] Prec. Charact. Gen. Insect. (1796) 129.
Oxybelus LATREILLE, Hist. Nat. Crust. Insect. 3 (1802) 343.
Notoglossa DAHLBOM,[17] Hymen. Europ. 1 (1845) 514.
Alepidaspis A. COSTA,[18] Att. Rendic. Acad. Sci. Fis. Napoli 9 (1882) 35.
Alepidaspis A. COSTA, Rendic. Acad. Sci. Fis. Napoli 21 (1882) 197.
Anoxybelus KOHL,[19] Konowia 2 (1923) 274.
Gonioxybelus MINKIEWICZ,[20] Polski Pismo Ent. 12 (1934) 251.
Orthoxybelus MINKIEWICZ, Polski Pismo Ent. 12 (1934) 251.

Subgenus ANOXYBELUS Kohl

OXYBELUS (ANOXYBELUS) MAIDLII Kohl.

Oxybelus (Anoxybelus) Maidlii KOHL, Konowia 2 (1923) 274, fig. 11; female, BALUCHISTAN, Abu.

Subgenus OXYBELUS (sensu strictu)

OXYBELUS (OXYBELUS) ÆQUIPUNCTATUM sp. nov.

Male. Luzon.

OXYBELUS (OXYBELUS) ÆSTUOSUM Bingham.

Oxybelus æstuosus BINGHAM, Faun. Brit. Ind., Hymen. 1 (1897) 318; male, LOWER BURMA, Tenasserim.

OXYBELUS (OXYBELUS) AGILE Smith.

Oxybelus agilis SMITH, Cat. Hymen. Brit. Bus. 4 (1856) 387; male.
Oxybelus sabulosus SMITH, Cat. Hymen. Brit. Mus. 4 (1856) 388; female.

[16] When Latreille defined the genus *Oxybelus* in 1796 he included no species. The first valid association of a species with this name was in 1802. [Mem. Amer. Ent. Soc. (9) (1937).]

[17] *Notoglossa* is at most but a species group, and is confined entirely to the Old World.

[18] Costa based his genus *Alepidaspis* on a teratological form of *Oxybelus lamellatum* Olivier, which he described as *Alepidaspis diphyllus*. The group is, in all probability, isogenotypic with *Notoglossa* Dahlbom, 1845.

[19] Retained provisionally as a subgenus of *Oxybelus* Latr.

[20] Minkiewicz proposed these names as subgenera of *Oxybelus*, basing them largely upon ethological characters, such as the type of nest constructed by the adult. As subgenera they are quite untenable, but they may be used for species groups. *Orthoxybelus*, however, is isogenotypic with *Oxybelus* Latreille.

Oxybelus agilis SMITH, Journ. Linn. Soc. 3 (1859) 18.
Oxybelus agilis SMITH, Proc. Linn. Soc. 7 (1863); Journ. Linn. Soc. 11 (1871) 368.
Oxybelus agilis CAMERON, Mem. and Proc. Manchester Lit. and Phil. Soc. (4) 3 (1890) 276.
Oxybelus sabulosus CAMERON, Mem. and Proc. Manchester Lit. and Phil. Soc. (4) 3 (1890) 276.
Oxybelus agilis BINGHAM, Faun. Brit. Ind., Hymen. 1 (1897) 316; male.
Oxybelus sabulosus BINGHAM, Faun. Brit. Ind., Hymen. 1 (1897) 316; female.
Oxybelus agilis DALLA TORRE, Cat. Hymen. 8 (1897) 638; male.
Oxybelus sabulosus DALLA TORRE, Cat. Hymen. 8 (1897) 647; female.
Oxybelus agilis TURNER, Mem. Dept. Agr. India, Ent. Ser. 5 (1917) 190; male, female.

OXYBELUS (OXYBELUS) ARGENTEOLINEATUS Cameron = CRABRO (LINDENIUS) ARGENTATUS Lepeletier et Brulle, 1835.

Oxybelus argenteolineatus CAMERON, Mem. and Proc. Manchester Lit. and Phil. Soc. (4) 3 (1890) 282.
Crabro (Lindenius) argentatus BINGHAM, Faun. Brit. Ind., Hymen. 1 (1897) 328.

OXYBELUS (OXYBELUS) AURIFRONS CAMERON, 1902, nec Smith, 1856 = OXYBELUS (OXYBELUS) PICTISENTIS Cameron, q. v.

Oxybelus aurifrons CAMERON, Journ. Bombay Nat. Hist. Soc. 14 (1902) 287; male (*nec* Smith, 1856).
Oxybelus aurifrons AYYAR, Journ. Bombay Nat. Hist. Soc. 24 (1916) 559.
Oxybelus pictisentis TURNER, Mem. Dept. Agr. Ind. Ent. Ser. 5 (1917) 190; male.

OXYBELUS (OXYBELUS) BANKSI (Ashmead) nom. nov.

Notoglossa banksi ASHMEAD, Proc. U. S. Nat. Mus. 28 (1905) 960; female.
Notoglossa banksi BROWN, Philip. Journ. Sci. 1 (1906) 686.

Male. Philippine Islands.

OXYBELUS (OXYBELUS) BANKSI fo. DIVARICATUM fo. nov.

Male. Mindanao.

OXYBELUS (OXYBELUS) BELLUS Cameron, 1890, nec Dahlbom, 1845 = CRABRO BELLULUS (Dalla Torre).

Oxybelus bellus CAMERON, Mem. and Proc. Manchester Lit. and Phil. Soc. (4) 3 (1890) 280 [*nec* Dahlbom, 1845].
Crabro bellus BINGHAM, Faun. Brit. Ind., Hymen. 1 (1897) 328; male [*nec* Cresson, 1865].
Oxybelus bellulus DALLA TORRE, Cat. Hymen. 8 (1897) 638.
Crabro bellulus SCHULZ, Spol. Hymen. (1906) 210.

OXYBELUS (OXYBELUS) BICOLORISQUAMA Strand.

Oxybelus bicolorisquama STRAND, Internat. Ent. Ztschr. 16 (1922) 172; male.

Oxybelus bicolorisquama YASUMATSU, Trans. Sapporo Nat. Hist. Soc. 1 (1935) 41.

Male. Formosa, Tainan.

OXYBELUS (OXYBELUS) BICOLORISQUAMA var. KANKAUENSE Strand.

Oxybelus bicolorisquama var. *kankauensis* STRAND, Internat. Ent. Ztschr. 16 (1922) 172.

Male? Formosa, Kankau.

OXYBELUS (OXYBELUS) CANESCENS Cameron.

Oxybelus canescens CAMERON, Mem. and Proc. Manchester Lit. and Phil. Soc. (4) 3 (1890) 278, pl. 10, fig. 22.

Oxybelus canescens BINGHAM, Faun. Brit. Ind., Hymen. 1 (1897) 320; male.

Oxybelus canescens DALLA TORRE, Cat. Hymen. 8 (1897) 639.

Oxybelus canescens ROTHNEY, Trans. Ent. Soc. London (1903) 106.

Oxybelus canescens PAIVA, Journ. and Proc. Asiatic Soc. Bengal 2 (1906) 348.

Male? Bengal, Barrackpore, Siliguri.

OXYBELUS (OXYBELUS) CEYLONICUM Cameron.

Oxybelus ceylonicus CAMERON, Mem. and Proc. Manchester Lit. and Phil. Soc. 41 (1896) 79.

Oxybelus ceylonicus AYYAR, Journ. Bombay Nat. Hist. Soc. 24 (1916) 559.

OXYBELUS (OXYBELUS) CEYLONICUS Cameron, 1900, nec Cameron, 1896 = OXYBELUS (OXYBELUS) TAPROBANENSE Pate, q. v.

Oxybelus ceylonicus CAMERON, Ann. & Mag. Nat. Hist. (7) 5 (1900) 40.

Oxybelus taprobanensis PATE, Ent. News 41 (1930) 20.

OXYBELUS (OXYBELUS) FLAVIPES Cameron.

Oxybelus flavipes CAMERON, Mem. and Proc. Manchester Lit. and Phil. Soc. (4) 3 (1890) 276.

Oxybelus flavipes BINGHAM, Faun. Brit. Ind., Hymen. 1 (1897) 319.

Oxybelus flavipes DALLA TORRE, Cat. Hymen. 8 (1897) 641.

Oxybelus flavipes ROTHNEY, Trans. Ent. Soc. London (1903) 106.

OXYBELUS (OXYBELUS) FORTICARINATUS Cameron = OXYBELUS (OXYBELUS) LAMELLATUM Olivier, q. v.

Oxybelus forticarinatus CAMERON, Journ. Bombay Nat. Hist. Soc. 18 (1908) 304; female, male.

Oxybelus lamellatus TURNER, Mem. Dept. Agr. Ind. Ent. Ser. 5 (1917) 192; female, male.

OXYBELUS (OXYBELUS) FULVICAUDIS Cameron.

Oxybelus fulvicaudis CAMERON, Journ. Bombay Nat. Hist. Soc. 18 (1908) 303; female.

Oxybelus fulvicaudis AYYAR, Journ. Bombay Nat. Hist. Soc. 24 (1916) 559.

Female. India, Bengal.

OXYBELUS (OXYBELUS) FULVOPILOSUM Cameron.

Oxybelus fulvopilosus CAMERON, Mem. and Proc. Manchester Lit. and Phil. Soc. (4) 3 (1890) 279, pl. 10, fig. 23; female.

Oxybelus fulvopilosus BINGHAM, Faun. Brit. Ind., Hymen. 1 (1897) 319; female.

Oxybelus fulvopilosus DALLA TORRE, Cat. Hymen. 8 (1897) 641; female.

Oxybelus fulvopilosus ROTHNEY, Trans. Ent. Soc. London (1903) 106.

Female. India, Bengal.

OXYBELUS (OXYBELUS) FURCIFERUM Turner.

Oxybelus furcifer TURNER, Mem. Dept. Agr. Ind. Ent. Ser. 5 (1917) 191; female, male.

Female, male. India, Bengal.

OXYBELUS (OXYBELUS) INSULARE Kohl.

Oxybelus insularis KOHL, Termesz. Füzet. 8 (1884) 109; female.

Oxybelus insularis CAMERON, Mem. and Proc. Manchester Lit. and Phil. Soc. (4) 3 (1890) 276.

Oxybelus insularis BINGHAM, Proc. Zoöl. Soc. (1896) 447; Faun. Brit. Ind., Hymen. 1 (1897) 318; female; DALLA TORRE, Cat. Hymen. 8 (1897) 641; female.

Female. Ceylon.

OXYBELUS (OXYBELUS) LAMELLATUM Olivier.

Oxybelus lamellatus OLIVIER, Encycl. Method., Insect. 8 (1811) 593.

Oxybelus Savignyi SPINOLA, Ann. Ent. Soc. France 7 (1838) 483; male.

Oxybelus Andalusicus SPINOLA, Ann. Ent. Soc. France (2) 1 (1843) 136; male.

Notoglossa sagittata DAHLBOM, Hymen. Europ. 1 (1845) 514; female.

Oxybelus arabs LEPELETIER, Hist. Nat. Insect., Hymen. 3 (1845) 212; female.

Oxybelus squamosus SMITH, Trans. Ent. Soc. London (1875) 38; female, male.

Notoglossa sagittata LICHTENSTEIN, Ann. Ent. Soc. France 64 (1875) xii.

Notoglossa arabs LICHTENSTEIN, Ann. Ent. Soc. France 64 (1875) xii.

Alepidaspis diphyllus A. COSTA, Rendic. Accad. Sci. Fis. Napoli 21 (1882) 197 [female].

Alepidaspis frondigera A. COSTA, Bol. Ent. Soc. Ital. 15 (1883) 334; male.

Oxybelus squamosus CAMERON, Mem. and Proc. Manchester Lit. and Phil. Soc. (4) 3 (1890) 276, pl. 10, fig. 24.

Oxybelus squamosus BINGHAM, Faun. Brit. Ind., Hymen. 1 (1897) 315; female.

Oxybelus squamosus DALLA TORRE, Cat. Hymen. 8 (1897) 648.

Oxybelus squamosus ROTHNEY, Trans. Ent. Soc. London (1908) 106.

Oxybelus forticarinatus CAMERON, Journ. Bombay Nat. Hist. Soc. 18 (1908) 304; female, male.

Oxybelus squamosus LEFROY, Ind. Ins. Life (1909) 209 (Biol.).

Oxybelus squamosus FLETCHER, South Indian Insects (1914) 280 (Biol.).

Oxybelus forticarinatus AYYAR, Journ. Bombay Nat. Hist. Soc. 24 (1917) 559.

Oxybelus lamellatus TURNER, Mem. Dept. Agr. Ind. Ent. Ser. 5 (1917) 192; female, male.

Female, male. India, Bengal, Punjab; Mesopotomia to Morocco.

OXYBELUS (OXYBELUS) LATILINEATUM Cameron.

Oxybelus latilineatus CAMERON, Journ. Bombay Nat. Hist. Soc. 18 (1908) 302; female.

Oxybelus latilineatus AYYAR, Journ. Bombay Nat. Hist. Soc. 24 (1917) 559.

Female. India, Bombay.

OXYBELUS (OXYBELUS) LEWISI Cameron.[21]

Oxybelus Lewisi CAMERON, Mem. and Proc. Manchester Lit. and Phil. Soc. (4) 3 (1890) 282.

Oxybelus lewisi BINGHAM, Proc. Zoöl. Soc. (1896) 447; Faun. Brit. Ind., Hymen. 1 (1897) 320.

Oxybelus lewisi DALLA TORRE, Cat. Hymen. 8 (1897) 642.

Oxybelus lewisi MATSUMURA, List useful Insects Japan (1908) 132.

Oxybelus lewisi YASUMATSU, Trans. Sapporo Nat. Hist. Soc. 14 (1935) 38.

Ceylon, Nugata. (? Japan, Hokkaido, Honshu).

OXYBELUS (OXYBELUS) LINGUIFERUM Turner.

Oxybelus (Notoglossa) linguifera TURNER, Mem. Dept. Agr. Ind. Ent. Ser. 5 (1917) 193; female.

Female. India, Punjab.

OXYBELUS (OXYBELUS) NANUM Bingham.

Oxybelus nanus BINGHAM, Faun. Brit. Ind., Hymen. 1 (1897) 317; male.

Male. Burma, Rangoon.

OXYBELUS (OXYBELUS) NIGRITULUM Turner.

Oxybelus nigritulus TURNER, Mem. Dept. Agr. Ind. Ent. Ser. 5 (1917) 189; female, male.

Female, male. Assam, Shillong.

[21] *O. lewisi* Cameron and *O. taprobanense* Pate (= *O. ceylonicus* Cameron, 1900 *nec* Cameron, 1896), were originally described by Cameron as "without laminæ" [*i. e.*, squamæ] and are still known only from the unique types, the former presumably in the British Museum and the latter in the Hope Museum at Oxford. I have not seen specimens of either of these, but they may eventually prove to be species of *Crabro* as have *O. bellus*, *O. nitidus*, and *O. argenteolineatus*, also described by Cameron in the same paper as species of *Oxybelus* "without laminæ". On the other hand, they may be merely teratological forms of other valid species, since occasionally specimens with malformed or aborted squamæ have been found and sometimes described as discrete species, *e. g.*, *Alepidaspis diphyllus* A. Costa, 1882 (= *Oxybelus lamellatum* Olivier, 1811).

OXYBELUS (OXYBELUS) NITIDUS Cameron = CRABRO NITIDUS (Cameron).

Oxybelus nitidus CAMERON, Mem. and Proc. Manchester Lit. and Phil. Soc. (4) **3** (1890) 281.

Crabro nitidus BINGHAM, Faun. Brit. Ind., Hymen. **1** (1897) 330; female.

Oxybelus nitidus DALLA TORRE, Cat. Hymen. **8** (1897) 646.

OXYBELUS (OXYBELUS) PHILIPPINENSE sp. nov.

Female. Philippines.

OXYBELUS (OXYBELUS) PHILIPPINENSE forma RETICULATUM fo. nov.

Female. Mindanao.

OXYBELUS (OXYBELUS) PICTISENTIS Cameron.

Oxybelus aurifrons CAMERON, Journ. Bombay Nat. Hist. Soc. **14** (1902) 287; male [*nec* Smith, 1856].

Oxybelus pictisentis CAMERON, Journ. Bombay Nat. Hist. Soc. **18** (1908) 302; female.

Oxybelus pictisentis AYYAR, Journ. Bombay Nat. Hist. Soc. **24** (1917) 559.

Oxybelus aurifrons TURNER, Mem. Dept. Agr. Ind. Ent. Ser. **5** (1917) 190; female [*nec* Smith, 1856].

Oxybelus pictiscutis TURNER, Mem. Dept. Agr. Ind. Ent. Ser. **5** (1917) 190; male. (*Pictiscutis* Turner = emendation for *pictisentis* Cameron, q. v.).

Female, male. India, Bombay, Punjab.

OXYBELUS (OXYBELUS) ROBUSTUM Cameron.

Oxybelus robustus CAMERON, Mem. and Proc. Manchester Lit. and Phil. Soc. (4) **3** (1890) 276, pl. 10, fig. 21; female.

Oxybelus robustus BINGHAM, Faun. Brit. Ind., Hymen. **1** (1897) 315; female.

Oxybelus robustus DALLA TORRE, Cat. Hymen. **8** (1897) 647; female.

Oxybelus robustus ROTHNEY, Trans. Ent. Soc. London (1903) 106.

Female. India, Bengal Province, Bombay.

OXYBELUS (OXYBELUS) RUFICORNIS Smith.

Oxybelus ruficornis SMITH, Cat. Hymen. Brit. Mus. **4** (1856) 388; female.

Oxybelus ruficornis CAMERON, Mem. and Proc. Manchester Lit. and Phil. Soc. (4) **3** (1890) 276.

Oxybelus ruficornis BINGHAM, Faun. Brit. Ind., Hymen. **1** (1897) 317; female.

Oxybelus ruficornis DALLA TORRE, Cat. Hymen. **8** (1897) 647.

Oxybelus sabulosus SMITH, Cat. Hymen. Brit. Mus. **4** (1856) 388; female. (= *Oxybelus agile* SMITH, q. v.)

Oxybelus agilis TURNER, Mem. Dept. Agr. Ind. Ent. Ser. **5** (1917) 190; male.

Oxybelus squamosus SMITH, Trans. Ent. Soc. London (1875) 38; female, male. (= *Oxybelus lamellatum* Olivier, q. v.).

Oxybelus lamellatus TURNER, Mem. Dept. Agr. Ind. Ent. Ser. **5** (1917) 192; female, male.

Female. India.

OXYBELUS (OXYBELUS) SULUENSE sp. nov.

Male, female. Borneo, Sandakan. Palawan, Puerto Princesa.

OXYBELUS (OXYBELUS) TAPROBANENSE Pate.[22]

Oxybelus ceylonicus CAMERON, Ann. & Mag. Nat. Hist. (7) 5 (1900) 40 [*nec* Cameron, 1896].

Oxybelus taprobanensis PATE, Ent. News 41 (1930) 20.

OXYBELUS (OXYBELUS) TRANSIENS Turner.

Oxybelus transiens TURNER, Mem. Dept. Agr. Ind. Ent. Ser. 5 (1917) 191; female.

OXYBELUS (OXYBELUS) TRIDENTATUM Smith.

Oxybelus tridentatus SMITH, Cat. Hymen. Brit. Mus. 4 (1856) 387; male.

Oxybelus tridentatus CAMERON, Mem. and Proc. Manchester Lt. and Phil. Soc. 3 (4) (1890) 276.

Oxybelus tridentatus BINGHAM, Faun. Brit. Ind., Hymen. 1 (1897) 317, fig. 88; male.

Oxybelus tridentatus DALLA TORRE, Cat. Hymen. 8 (1897) 649.

Male. India. Lower Burma, Tenasserim.

OXYBELUS (OXYBELUS) XANTHOGASTER sp. nov.

Female. Borneo, Lebang Hara.

[22] See remarks in footnote 21 on *O. Lewisi.* In the case of *O. taprobanense* there is a possibility that since there is neither description nor mention made of the propodeal spine or mucro, it may be referable to either *Belomicrus* or *Belomicroides* inasmuch as Cameron (loc. cit.) definitely states that ". . . . this species is referable to *Oxybelus,* rather than to *Crabro,* although it has not got any thoracic laminæ, through the submarginal cellule being confluent with the first discoidal, and through the eyes not being convergent toward the vertex . . ."

ILLUSTRATION

PLATE 1

FIG. 1. *Oxybelus suluense* sp. nov., squamæ and mucro of male.
2. *Oxybelus banksi* (Ashmead), squamæ and mucro.
3. *Oxybelus banksi* forma *divaricatum* fo. nov., squamæ and mucro.
4. *Oxybelus suluense* sp. nov., mucro of female.
5. *Oxybelus philippinense* sp. nov., clypeus.
6. *Oxybelus xanthogaster* sp. nov., mucro.
7. *Oxybelus suluense* sp. nov., clypeus of female.
8. *Oxybelus suluense* sp. nov., clypeus of male.
9. *Oxybelus xanthogaster* sp. nov., clypeus.
10. *Oxybelus banksi* (Ashmead), clypeus.
11. *Oxybelus philippinense* sp. nov., squamæ and mucro.
12. *Oxybelus æquipunctatum* sp. nov., squamæ and mucro.

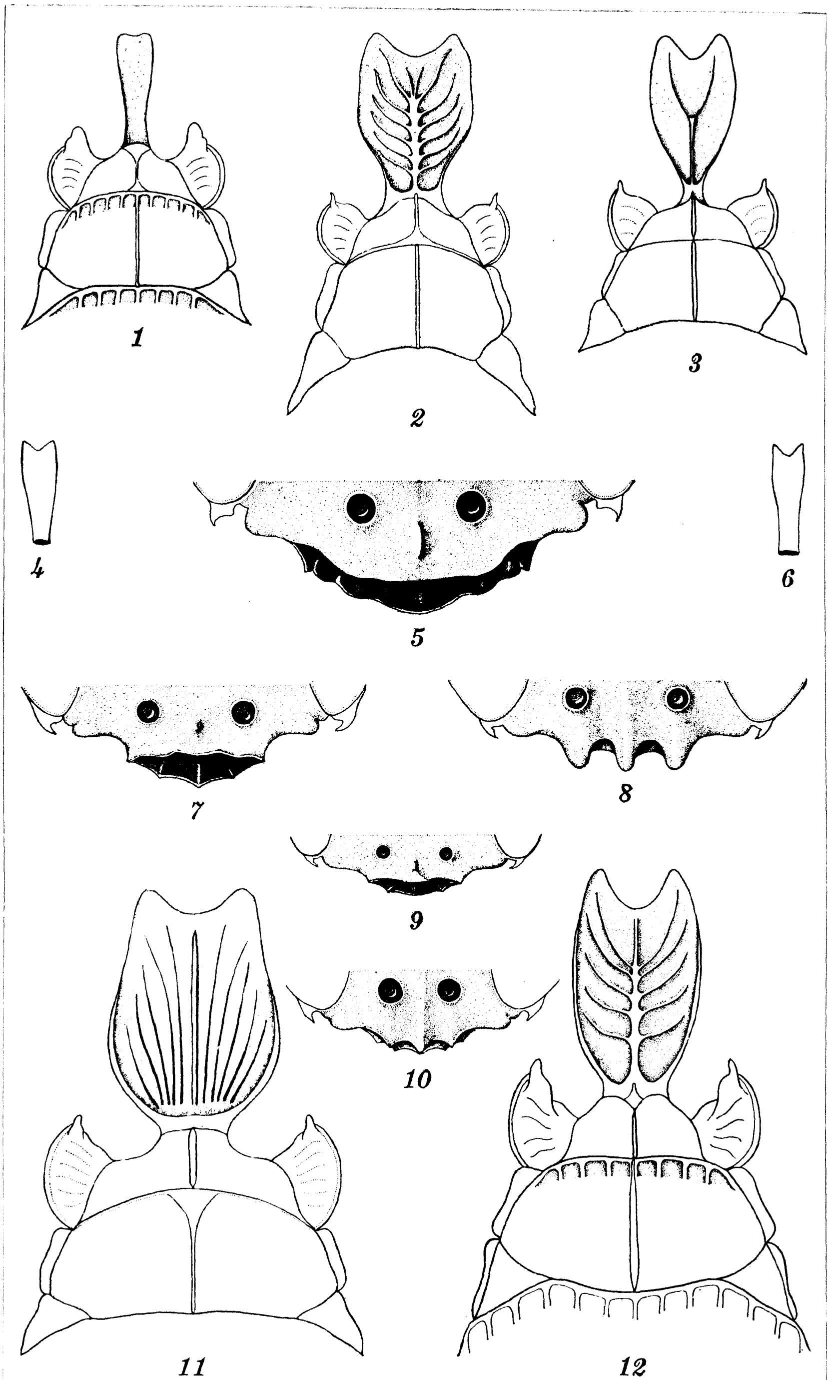

PLATE 1.

NOTES ON EUPHORBIACEÆ, WITH A NEW GENUS AND A NEW SUBTRIBE OF THE EUPHORBIEÆ

By LEON CROIZAT

Of the Arnold Arboretum, Harvard University

ONE PLATE AND ONE TEXT FIGURE

In a recently published paper(7) I mentioned *Euphorbia Cleopatra* Baill., a New Caledonian endemic, as possibly related to *E. Ridleyi* Croiz. (*E. Synadenium* Ridl.), which is strictly confined to the vicinity of Singapore. At the time *E. Cleopatra* was known to me from description, but later I was able to examine specimens of it, including the actual type, courteously loaned by the Museum d'Histoire Naturelle of Paris. For this extraordinary favor I am indebted to the kindness of Prof. H. Humbert and Prof. A. Guillaumin of that institution. To Dr. P. Santer, of the Jardin de l'Etat in Brussels, I am indebted for the receipt of cymes of *Monadenium* from type specimens.

A perfunctory examination of the material makes it clear that Baillon altogether misunderstood the characters of this very distinct plant. The collector, Pancher, showed excellent judgment in labelling it *in schedis* as a new genus, calling it *Cleopatra Candelabra.* The systematic and taxonomic work of Baillon is well known to be of uneven quality, but it is surprising that Pancher's generic name, cited by Baillon as a synonym of *Euphorbia Cleopatra,* was never accepted by later authors. Boissier did not see the type specimen. He used Baillon's binomial,(4) although a hint of misgiving may be read in his notes when he redescribed the species from Baillon's account. Pancher himself, working in collaboration with Sebert,(15) listed *E. Cleopatra,* and made no mention of his former unpublished generic name, even as a synonym.

Baillon(2) presents *E. Cleopatra* together with, and under the section, *Decadenia. Decadenia* is outstanding even among the often peculiar sections that have been proposed within the Linnæan genus, *sensu latiore,* and which rather hopelessly confuse its classification. It is described as follows:

Calyx (involucrum *Lamk.*) profunde 5-partitus, laciniis integris reflexis. Stamina (flores masculi *Lamk.*) 5-fasciculata, filamentis ad medium articulatis. Glandulae staminales (calyx masc. *Lamk.*) inaequales

imbricatae. Glandulae hypoginae 5 calycis laciniis alternae, basi attenuata, apice incrassato recte truncato; quarum 5 sub pistillo insertae staminum fasciculis alternae, 5 alterae exteriores cum calycis lobis alternantes. Pistillum stipitatum 3-merum, disco cupulaeformi brevi inaequali 5-6-lobo (calyce *Lamk.*) munitum.—BAILLON, Species *Euphorbiacearum*, 213, 214.

On the surface this diagnosis characterizes an incredible *Euphorbia,* granting that it makes sense at all. The "glands" (nectaria, as I understand these organs) are stated correctly to be ten in Baillon's original description. The error found in the generic diagnosis is easily detected, and may not be serious. However, so far as I know, a true *Euphorbia* cannot have nectaria inserted or attached "below the pistil."

Genus NEOGUILLAUMINIA Croizat gen. nov.

Perianthii laciniis 4 ad 5, liberis, petaloideis, eglandulosis, fasciculis florum masculorum oppositis. Fasciculis florum masculorum 4 ad 5, bracteatis. Flore foemineo centrali, 3-loculari, bracteato. Nectariis 8 ad 10, binis inter quaeve fascicula florum masculorum, stipitatis, toro (seu apici incrassato inflorescentiae pedunculi) insidentibus, a flore foemineo radiantibus.

Perianth of 4 to 5 free petaloid eglandular appendages opposite the fascicles of male flowers. Fascicles of male flowers 4 to 5, bracteate. Female flower central, 3-locular, bracteate. Nectaria (glands auct.) 8 to 10, in pairs between the fascicles of male flowers, stipitate, attached to the torus (enlarged apex of the inflorescence peduncle), radiating from the female flower.

NEOGUILLAUMINIA CLEOPATRA (Baill.) comb. nov.

Euphorbia Cleopatra BAILLON, Adansonia (1861) 213; BOISSIER, DC. Prodr. 15^2 (1864) 1265; SEBERT and PANCHER, Sebert, Notice Bois Nouv. Caléd. (1874) 237.

Cleopatra Candelabra PANCHER, mss. in scheda, et in syn. apud Baillon.

Type specimen: Pancher 5766 [1], Coll de bois No. LIV" Bel arbre de 20 à 25 mètres, à branches presque verticillées, peu rameuses, élé gamment relevées en candelabre. Suc propre trèes abondant. Fleurs blanchâtres en février. Ravins ferrugineux du N. E. Calédonie."—PANCHER, *mss. in scheda.*

Type in the Herbarium of the Museum of Paris.

The brittleness of the type specimen, and of a second sheet representing the same species (Franc 268 [a], Prony, January, 1914) also kindly loaned by Professor Humbert, discourages handling for the purpose of describing in detail the vegetative parts. A detailed diagnosis does not seem to be required for this

very striking monotype. The notes of Baillon, Boissier, Pancher, and Sebert appear adequate once the inflorescence has been reinterpreted. The label of the type specimen definitely describes the plant as a tree 20 to 25 meters tall. The height given by Baillon as 6 to 8 meters in his diagnosis was written at first on the label by Pancher, and later crossed out. I cannot detect traces of stipules, and incline to the belief that they are absent. The plant seems to possess horticultural merits no less than an interest for the student of comparative morphology. The "flowers," although not more than 2 cm in diameter, have conspicuous whitish petaloid appendages. Specimens most likely exists that match the beauty of the "frangipanis" of common cultivation.

It is fortunate that the International Code does not absolutely require the acceptance of a sectional name when its rank is changed, because in the case under consideration the elevation of *Decadenia* would require an amended description. Pancher's binomial, published so far as I have been able to establish only in synonymy, may also be disregarded, since the use of a name in synonymy does not constitute proper publication. While the just regard of Pancher's achievement in recognizing at least once this plant as a distinct genus suggests that his binomial be reinstated, it is feared that such use of *Cleopatra* may encourage the assumption that Pancher's plant is only one among the controversial segregates of *Euphorbia*. In presenting a new generic name in honor of Prof. A. Guillaumin it is my intention to dissociate this peculiar plant from the species that indeed belong to the *Euphorbia* of Linnæus.

So far as I know, *Neoguillauminia* is monotypic, and I have already spoken of it as such. Thanks to the courtesy of Professor Humbert I have had the opportunity of examining a leaf of the type of *E. Brownii* Baill. (Baudin ? "Nouvelle Hollande, côte occidentale") which Baillon believed also to belong to *Decadenia*. Not having seen the "flowers" which are described as immature(3) I cannot decide whether or not this species, too, belongs to *Neoguillauminia*. I am inclined to the negative, however, since the midrib does not extend to the apex of the blade as in *N. Cleopatra*, and the nervation has a different character.

The systematic position of *Neoguillauminia* raises issues not less interesting than those of plant migration and comparative morphology which must for the present remain outside the scope of this treatment. Accepting the authority of the most

recent reference work on the Euphorbiaceæ,(12) the Euphorbieæ possess a normally bisexual cyathium, the individual male flowers reduced to a single stamen. The tribe includes ten genera, *Anthostema, Dichostemma,*[1] *Diplocyathium, Euphorbia, Calycopeplus, Elæophorbia, Synadenium, Monadenium, Stenadenium, Pedilanthus.* The relationship among these genera with the exception of *Titymalus*[2] is interpreted by Pax(11) in a fan-shaped graph in which, reading left to right, *Diplocyathium* stands alone, *Anthostema* and *Dichostemma* are placed in a single affinity, *Calycopeplus, Euphorbia,* and *Elæophorbia* are grouped together, and *Synadenium, Monadenium,* and *Stenadenium* share a common branch of the tribal tree.

In a discussion of the Euphorbieæ the cyathium must necessarily be considered, because in current taxonomy it is used as the character of *Euphorbia* and as the tribal character of the entire group. The nature and genesis of this peculiar inflorescence have been treated in numerous works among which Schoute's(14) Haber's,(9) and one contribution of my own which was written in a wholly informative spirit(6) may be recorded.

The appended bibliography will be of assistance to those interested in forming an independent opinion on the subject. The

[1] The name is frequently erroneously spelled *Dichostema.*

[2] The use made by Small(16) of *Tithymalus* instead of *Pedilanthus* appears to have given rise to a certain amount of criticism. Judging Small's interpretation to be unassailable I quote from Miller(10) the presentation of *Tithymalus* as it occurs in the original, with very minor omissions: "The Characters are: the Flower has an Empalement of one Leaf, indented in three Parts: it has one Petal which is shaped like a Slipper; it is of a thick fleshy Consistence. Under the upper Part of the Flower are situated ten Stamina, which are inserted in the Receptacle of the Flower; they are slender, and terminated by globular Summits; in the Center is situated a roundish three-cornered Germen, supporting three bifid Styles, crowned by oblong Stigmas. The Germen afterwards becomes a roundish Capsule having three Cells, each containing one oval Seed. This Genus of Plants is by Linnæus joined to the *Euphorbia.* But as the Flowers of this Genus differ greatly in their structure from those of *Euphorbia,* I have chosen to separate them, and have continued the old Title of *Tithymalus* to the Genus." Miller's lucid account is the earliest recorded segregation from the Linnæan farrago. It should be noticed that Miller cites in synonymy the genus *Tithymaloides* Tourn., not *Tithymalus* eiusd. auct., and introduces two species, with synonyms, respectively. *Tithymaloides frutescens folio myrti amplissimi Tourn. Inst.* 654, and *Tithymaloides foliis laurocerasi folio non serrato Hort. Elth.* 383, which could scarcely be clearer. There is no question of *nomen confusum* as *Tithymalus* and *Pedilanthus* have been applied to distinct groups of plants by the majority of authors.

"discovery" of *Neoguillauminia* hidden for nearly four score years in the *Euphorbia* jungle indicates better than anything else how much remains to be done in the proper interpretation of the Euphorbiaceæ. It is clear that the question of the cyathium is still in a controversial stage, and I venture to surmise that it may not be solved satisfactorily except through the collective endeavors of students of the various branches of botanical discipline.

Today all investigators agree that the cyathium is an inflorescence. This unanimity of opinion is gratifying. The taxonomical concept that subscribes to the Linnæan genus fundamentally interprets the cyathium as a flower. Regardless of side issues, however, the cyathium is generally accepted as representing an aggregate of flowers with their appurtenances: the female flower (ovary *auct.*) is surrounded by free or fascicled male flowers (stamens *auct.*). The sexual organs are included within a perianth (involucre) composed of two adnate series: the lobes, usually introrse, or erect, facing the fascicles of male flowers: the nectaria (glands) usually extrorse and melliferous, and often furnished with petaloid appendages.

Much attention has been given to the fact that the fascicles of male flowers show a spiral arrangement apparently in harmony with the laws of phyllotaxis, and the vernation of highly specialized species has been discussed in general terms. In my judgment it is wholly irrelevant whether or not the male flowers of *Euphorbia* show a spiral ratio amenable to fractional expression, because the cyathium is a shortened floral axis, not a foliate branchlet. I am not aware that the phyllotaxic rhythm of *Salicaceæ, Malvaceæ,* and others, extends to the ament in the one case and to the staminal column in the other, and it seems a far-fetched interpretation that attributes to the lobes of the cyathium the duties and prerogatives of phyllodes in good standing. Troll's interpretation of the cyathium,(17) which was promptly and effectively disposed of by Goebel,(8) appears still to influence the premises of some investigators.

The Euphorbieæ are correctly treated as a tribe of the Euphorbiaceæ Hippomaneæ. In the amentlike inflorescence of this important group all the parts that are found in the cyathium appear in the same or nearly the same degree of evolution (or retrogression, according to the opinion of some authors). In the cyathium occur laciniæ, scales, nectaria, clusters of male flowers, and calyculi closely approaching, if not identical with, those of

the Hippomaneæ. So far as I am able to discern, the difference, aside from the obvious results of adnation, is mainly that in the Hippomaneæ the female flowers are inferior in the scheme of the whole inflorescence, while in the Euphorbieæ the single female flower is strictly superior and terminal in respect to the axis to which the male flowers are attached.[3] Thus the floral axis of the Euphorbieæ and of the Hippomaneæ may be conceived to vary fundamentally only in the position of the female flower. All the differences due to adnation and to crowding of parts appear to depend in the last analysis upon the position of the female flower, or, let us say, upon the adaptation to the method of pollination either by wind and gravitation, or by insects. At least within the limits of these notes it is permissible to conclude that a terminal female flower on the bisexual florigerous axis constitutes the essence of a member of the Euphorbieæ. Important but not essential is an involucre to include the sexual organs.

On the basis of this assumption a sharp distinction is established between the Euphorbieæ that possess a cyathium with a more or less cup-shaped involucre, and those which have not such a cyathium. Although in *Euphorbia* are found species with peculiar cyathium structures (*E. pedilanthoides, E. capitulata, E. complexa* and others) it is manifest that the zygomorphic inflorescence of *Tithymalus* and the peculiar cyme of *Anthostema* require separate consideration. Nor can any species or genus belong to Euphorbieæ which lacks a terminal female flower.

Baillon, in fact, excluded *Anthostema* from the Euphorbieæ and attributed it to the Hippomaneæ, near *Sapium*,(1) on the ground that in *Anthostema* the female flower has a lateral, not a central, position in relation to the male flowers. The student of botanical history is here treated to a classic Baillonian procedure in which a mistaken observation is made the starting point of a treatment that is unassailable on the ground of formal logic, once the main premise has been granted. So far as I have been able to learn in *Anthostema* the so-called pedicel of the female flower represents the true florigerous axis, the latter being distorted by the lateral growth of a voluminous aggregate of male flowers. Obviously, the female flower of *Anthostema* is still superior and terminal; a true sympodium need not be mistaken for a zigzag series of internodes. In other words a grow-

[3] Terminal female flowers are known in Euphorbiaceæ outside of Euphorbieæ in *Micrococca, Omphalea,* and others. The points at issue, however, are the constancy of characters and the general relationship.

ing axis does not lose its essential monoxial nature when it is forced out of perpendicular alignment by the sheer thrust of secondary axes arising laterally from it. The inflorescence of *Anthostema* may be interpreted for the sake of elucidation as a dimidiate involucre of *Euphorbia*. The nectaria of *Anthostema*, however, have a different position from those of *Euphorbia:* they stand between the clusters of male flowers and are attached by a narrow base to one side of the gynophore. It is plain that *Anthostema* belongs to the Euphorbieæ and that the argument of Baillon, while extremely interesting, is based upon a fundamental misapprehension of the nature of the tribe.

Pierre, the author of *Dichostemma*, doubted(13) whether his genus would prove better than a section of *Anthostema*. The two genera, in fact, have several characters in common: they possess calyculate male flowers, nectaria placed between clusters of bracteate male flowers, and comparatively small involucres or perianth bracts. In *Dichostemma*, however, occurs a cup-shaped, mono- or bisexual perianth with four to five nectaria alternating with as many clusters of male flowers, and radiating from the female flower or its rudiment. The perianth of *Dichostemma* is a symmetric cyathium, which brings the genus close to *Euphorbia*, not an asymmetric perianth bract like that of *Anthostema*. From *Euphorbia Dichostemma* differs in the position and attachment of the nectarium, which in the former belongs to the involucral series and is free from the base of the gynophore. In *Dichostemma* the nectarium, voluminous in proportion to the generally small cyathium, is adnate both to the perianth and to a somewhat enlarged torus at the base of the gynophore. Thus it acts like a septum, or partition, between the clusters of male flowers, and its lateral faces are excavated better to accommodate such clusters. When the nectarium falls, a subdolabriform to dolabriform scar marks its former insertion upon the torus. The anterior face of the nectarium presses against the gynophore which, being surrounded by four nectaria, tends to assume a manifest quadrangular shape.

N. E. Brown(5) gives the following interpretation of *Dichostemma:*

> In structure the involucre really consists of 8 bracts more or less fused together: an outer series of 4, forming 4 pocket-like cavities at the corners containing the stamens, and an inner series of 4 alternating with the outer and converted into glands, surrounding in some of the terminal involucres a perfect female flower, in the others a very rudimentary abortive female flower, reduced to a very short solid square central body.

It is difficult if not impossible to agree that bracts can become transformed into glands, and it seems probable that N. E. Brown really means that four clusters of male flowers are reduced and adapted to nectariferous (glandular) functions. This is a distinct possibility in my opinion, but the problem presented by the nectaria of Euphorbieæ is not to be solved except by the investigation of all the nectaria of the Euphorbiaceæ, and as such must be left entirely outside the limits of this treatment.

Calycopeplus is as perfect an example of a connecting link as a morphologist may wish for. Let us suppose that three to five male calyculi of one of the Hippomaneæ, for instance, *Sapium,* are grouped together around a female superior flower, and that the faces of the calyculi that are away from the gynophore become adnate to form a continuous perianth with a minute nectarium at its rim where the sutures have developed. The result of the suggested process is the inflorescence of *Calycopeplus,* barring only irrelevant details. *Calycopeplus* is very near *Euphorbia* and may be accepted for an archetype of it. Its relationship with peculiar species so far accepted as *Euphorbia, E. complexa* for instance, requires further study.

Euphorbia is too well known to require elucidation. *Tithymalus* [4] presents considerable difficulties of morphological interpretation, and one of its historic segregates, *Cubanthus,* may not be discussed except in an exhaustive treatment, which is impossible here. The issue that *Tithymalus* and *Cubanthus* offer to the student's attention full series of cyathia of *Euphorbia* in which appears a tendency towards zygomorphism should be investigated, beginning with good material of a Madagascar species, *E. pedilanthoides,* which I regret to know only from description. *Cubanthus* appear to stand alone, probably connecting certain *Euphorbia* (for instance, the species of the so-called section *Poinsettia*) with *Tithymalus.* It may be suggested, at least as a line of investigation, that *Tithymalus* and *Cubanthus* represent in Euphorbieæ a distinct branch to be located not very far from the horizon of *Calycopeplus.* As such I have illustrated them (text fig. 1).

Monadenium may be disposed of in a brief review by comparing it with the species of the so-called section *Poinsettia.* In the latter the normal cyathium has one nectarium of small size

[4] Needless to say *Tithymalus* is accepted throughout this contribution in lieu of *Pedilanthus,* which is the generic name usually known to taxonomists.

in respect to the involucre; in *Monadenium* the nectarium is much enlarged, and surrounds more than three-quarters of the perianth's mouth, leaving free a deep cleft through which protrudes the gynophore. *Stenadenium,* which I know only from description, does not appear to differ basically from *Monade-*

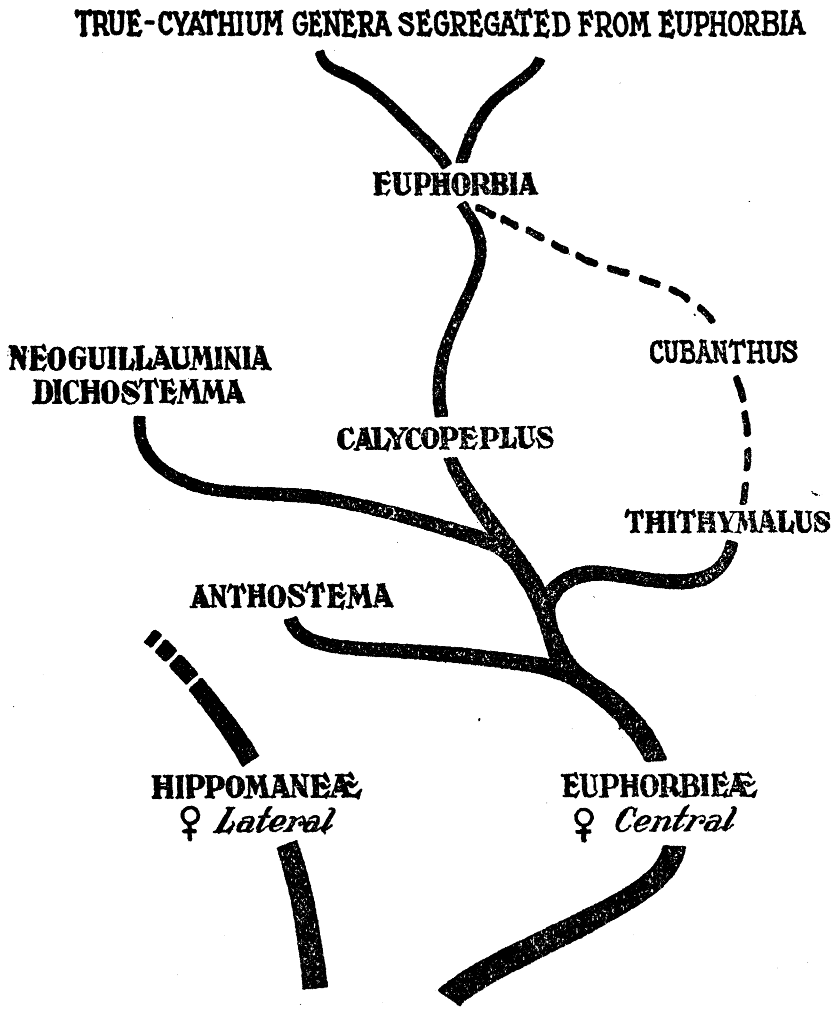

FIG. 1. The relationship of the Euphorbieæ. Position of the female flower with regard to the whole florigerous axis (male and female inflorescences *auct.*).

nium, except in the elongation of the nectarium above the mouth of the involucre. *Synadenium* is distinct from *Euphorbia* in that the nectaria are connate in a continuous ring. The imperfect cyathium which ends the main axis of the cyme of *Syna-*

denium, however, is very frequently observed with discrete nectaria, which should be duly noticed, and should give pause to taxonomists who segregate *Synadenium* from *Euphorbia* on the merit of "floral characters." *Calycopeplus, Monadenium, Dichostemma*, and *Synadenium* are illustrated in Plate 1, figs. 2 to 5, together with schematic floral diagrams intended to emphasize the position, and, in part, the size of the nectaria in the general plan of the cyathium. Excellent illustrations of *Anthostema* are available elsewhere in the literature.

Neoguillauminia has a superior central female flower which definitely settles its systematic position among the Euphorbieæ. It lacks a cup-shaped perianth which places it outside *Calycopeplus, Euphorbia*, and the true cyathium genera. It stands apart from *Tithymalus* in general characters. It barely nears *Anthostema* in the nectaria being inserted between the clusters of male flowers. *Dichostemma* it approaches in at least three points, as follows: (*a*) The presence of a torus at the base of the gynophore to which are attached the nectaria; (*b*) the presence of bracts surrounding the flowers; (*c*) the position of the nectaria which are radially located in respect to the female flower.

The differences between the two genera, aside from habit characters, may be summarized as follows: (*a*) In *Dichostemma* a perfect involucre occurs; in *Neoguillauminia* the perianth is reduced to four or five petaloid appendages and the nectaria are wholly free. (*b*) In *Dichostemma* the nectaria are four or five; in *Neoguillauminia* they are twice that number. (*c*) In *Dichostemma* the male flowers are calyculate, like those of *Anthostema;* in *Neoguillauminia* they are ecalyculate, like those of *Euphorbia*.

The difference in male flowers and in perianth between *Neoguillauminia* and *Dichostemma* is undoubtedly important, and it is furthermore undeniable that *Anthostema* is related to, and distinct from them, in characters which in the condition of present knowledge are so elusive as to stultify any attempt to group the three genera in a natural arrangement. I may venture the opinion that *Dichostemma* is the key genus of the systematic complex at hand, and that *Neoguillauminia* and *Anthostema* are about equidistant from it. *Neoguillauminia* lacks a cyathium-like perianth, but its ultimate inflorescence [5] is symmetrically

[5] As "ultimate inflorescence" I understand the aggregate of male and female flowers which is usually inclosed within the involucre, distinguishing it from the "inflorescence" which in the works now current connotates the cyme, or pseudoumbel.

disposed in respect to the florigerous axis, and the free petaloid appendage that subtends the clusters of male flowers may correctly be interpreted to represent a lobe or scale, the elements of the perianthic series being suppressed opposite the nectaria. *Anthostema's* ultimate inflorescence is asymmetric, but in it appear the calyculate male flowers that are found in *Dichostemma* and missing in *Neoguillauminia*. Thus the main issue that must be solved to group the three genera in appropriate subtribes is fundamentally expressed in the query: Is the symmetry, or asymmetry, of the ultimate inflorescence of greater systematic significance than the presence, or absence, of calyculate male flowers?

I am not aware that the answer can be returned with the subsidy of the knowledge at hand, and I regret that too often classification is made imperfect by the want of careful morphologic interpretation. Considering as best I can at this hour the probable taxonomic value of calyculate and ecalyculate male flowers in Euphorbieæ I notice that the rudiment of a calyculus, or at least a peculiar swelling of the articulation of the filament, appears in *Cubanthus*, and I incline to the belief that individuals, if not species, of the Euphorbieæ may be found outside *Dichostemma* and *Anthostema* which possess traces of calyculi and, perhaps, calyculi in full development. I know that every conceivable aberration is present in some individual or species of the Euphorbieæ, involving cyathium structure, number of spines, development of axes, sexuality, and others. I may presume, consequently, that the value to be derived from the single character of the calyculus of the male flower is less important than that concerning the arrangement of the ultimate inflorescence.

Whether this assumption will prove true depends on the result of work as yet incomplete. It might be shown that the ultimate inflorescence of *Anthostema* is to be assimilated to a cyathium of *Dichostemma* in which the perianth is laterally cleft to the very base. Such clefts, although not reaching below the middle of the cyathium, are known in *Monadenium* and in *Euphorbia*. If it should ever be proved that the ultimate inflorescence of *Anthostema* is of this nature, the genus must be considered as a derivative from cyathium prototypes to which *Dichostemma, Calycopeplus*, and *Euphorbia* have remained true, and *Anthostema* on the strength of its calyculate male flowers would fall in the subtribe of *Dichostemma*. However, it is about as probable that the cyathium is composed of adnate series of scales subtending clusters of male flowers alternating with nec-

taria, all of which elements in the elongated florigerous axis of the prototype had a definite spiral disposition. In this case the character expressed by the calyculus of the male flowers has barely a relic value, and it is almost irrelevant by contrast with the characters to be derived by the symmetry of the ultimate inflorescence: *Neoguillauminia* must follow *Dichostemma,* and *Anthostema* must stand alone.

The systematic issue presented by *Neoguillauminia* and its allies *Dichostemma* and *Anthostema,* unfortunately, may not be held in abeyance awaiting the result of the work of the morphologist. At present I am inclined to the belief that *Neoguillauminia* and *Dichostemma* may be accepted as members of the same subtribe, for which I propose the name Neoguillauminiinæ.

Subtribus NEOGUILLAUMINIINÆ novum

Euphorbieæ. Inter subtribus omines nectariis (glandulis auct.) a flore foemineo radiantibus distincta.

Genus typicum: *Neoguillauminia.*

The affinities of the new subtribe with the remaining genera of the tribe are tentatively indicated in text fig. 1. In this figure no account is taken purposely of *Monadenium, Synadenium, Elaeophorbia,* and of the remaining cyathium genera which must follow *Euphorbia.* Grave doubts attach to the propriety of a concept that mistakes an inflorescence for a flower, insists on misconstrued "floral characters" all too readily segregates from the Linnæan genus monotypes or olygotypes like *Diplocyathium, Elaeophorbia,* and others, on the strength of nearly specialized structures. Such a concept at the same time overlooks, or repudiates, whole series of characters like appendages, septa, stipules, spines, and others common to hundreds of species forming the natural groups of *Euphorbia* L.

BIBLIOGRAPHY

1. BAILLON, H. Anthostemidearum sive Euphorbiacearum monandrarum descriptiones. Ann. Sc. Nat. IV Bot. 9 (1858) 192–204.
2. BAILLON, H. Species Euphorbiacearum: Euphorbiaceae Neo-Caledonicae. Adansonia 2 (1861) 213, 214.
3. BAILLON, H. Species Euphorbiacearum: Euphorbiacées Australiennes. Adansonia 6 (1865) 290, 291.
4. BOISSIER, E. Euphorbieae. De Candolle, Prodr. 15^{2} (1864) 1265.
5. BROWN, N. E. Euphorbiaceæ. Thiselton-Dyer, Flora Trop. Afr. 6^{1} (1912) 605.
6. CROIZAT, L. On the classification of Euphorbia. I. How important is the cyathium? Bull. Torrey Club 63 (1936) 525–531.

7. CROIZAT, L. An early tertiary relict in Malaya, Euphorbia Ridleyi. Gard. Bull. Straits Settl. **9** (1937) 145–151.
8. GOEBEL, K. Blütenbildung und Sprossgestaltung. Zweiter Ergänzungsband zur Organographie der Pflanzen (1931) 198 [footnote 1].
9. HABER, J. M. The Anatomy and the Morphology of the Flower of Euphorbia. Ann. Bot. **39** (1925) 657–707.
10. MILLER, PH. The Gardeners Dictionary, 7th ed. (1759) "Tithymalus."
11. PAX, F. Die Phylogenie der Euphorbiaceae. Bot. Jahrb. **59** (1925) 152.
12. PAX, F., and K. HOFFMAN. Euphorbiaceae. Engl. and Prantl, Naturl. Pflanzfl. ed 2 **19** c (1931) 43, 44; 207–223.
13. PIERRE, L. Plantes du Gabon: Dichostemma. Bull. Soc. Linn. Paris **2** (1896) 1260.
14. SCHOUTE, J. C. On the aestivation in the cyathium of Euphorbia fulgens, with some remarks on the interpretation of the cyathium in general. Rec. Trav. Bot. Néerl. **34** (1937) 168–181.
15. SEBERT H. [and I. PANCHER.] Notice sur les bois de lc Nouvelle Caledonie (1874) 237.
16. SMALL, J. K. Manual of the Southeastern Flora (1933) 804.
17. TROLL, W. Organization und Gestalt im Bereich der Blüte (1928) 154–173.

ILLUSTRATIONS

Plate 1

[Schematic drawings prepared by the author from specimens in fluid.]

FIG. 1. *Neoguillauminia*, inflorescence and floral diagram; inflorescence shortly before anthesis; about × 3.

2. *Calycopeplus*, inflorescence and floral diagram; cyathium at the beginning of anthesis; about × 9.3.

3. *Monadenium*, inflorescence and floral diagram; cyathium in anthesis; about × 4.

4. *Dichostemma*, inflorescence and floral diagram; cyathium shortly before anthesis; about × 3.3.

5. *Synadenium*, inflorescence and floral diagram; cyathium in the female stage of anthesis, about × 4.

TEXT FIGURE

FIG. 1. The relation of the Euphorbieæ; position of the flower with regard to the whole florigerous axis (male and female inflorescence *auct.*).

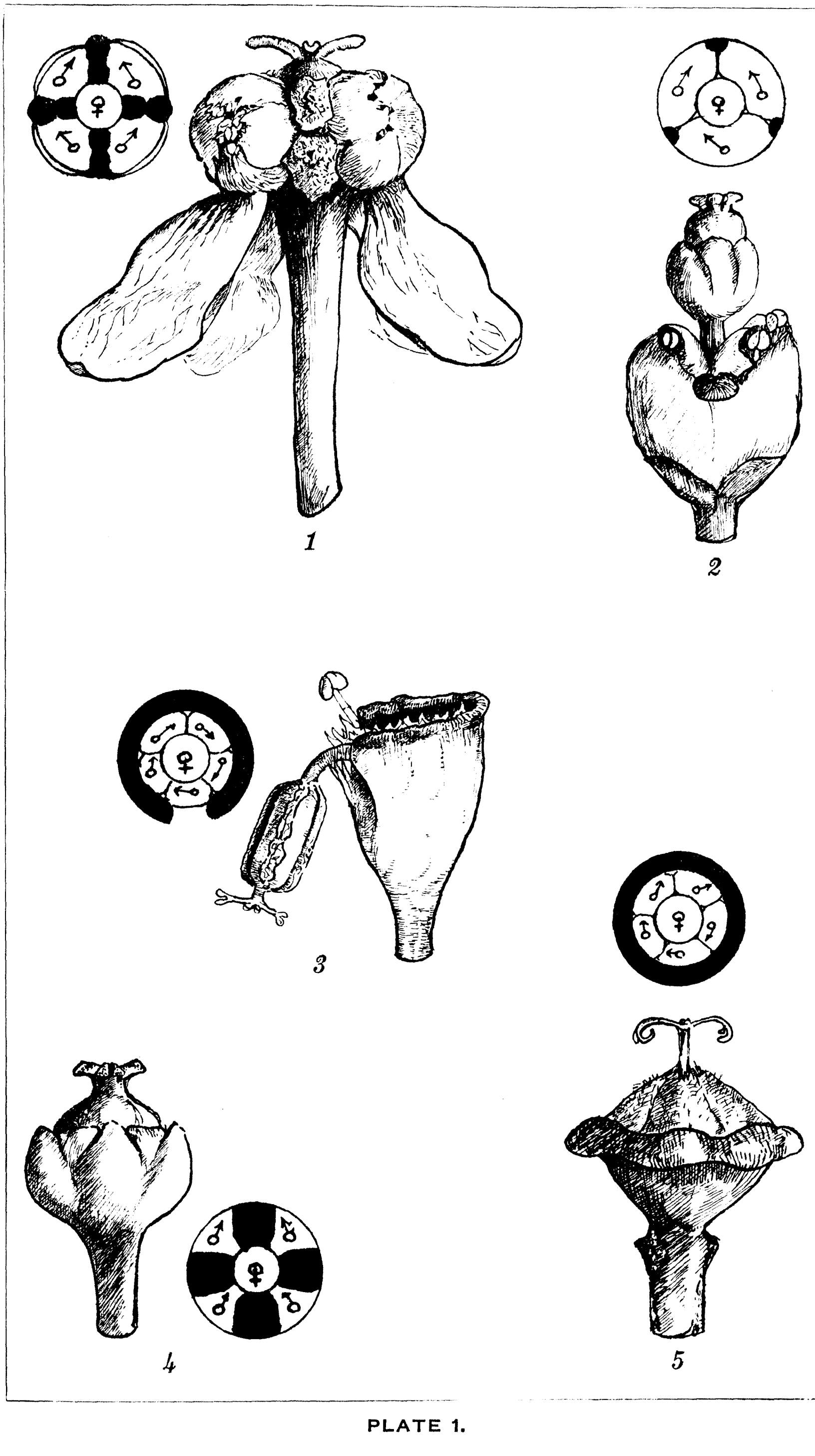

PLATE 1.

ILOKO FURNITURE AND IMPLEMENTS

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TWO PLATES

In a previous paper, published in the Philippine Journal of Science,[1] we discussed Iloko constructions.

In this paper we shall try to describe as accurately as possible the different pieces of furniture and the implements used by the Iloko, excluding, however, anything that has reference to weaving (clothes, baskets, nets), hunting, fishing, and similar pursuits.

We shall avoid as much as possible all words that are obviously of Spanish origin, and we shall give only those that came to our personal notice, alphabetically arranged for the greater convenience of the missionary and the explorer.

ILOKO FURNITURE AND IMPLEMENTS

abbóñg: Cover, wrapper. Cf. *akkúb* & *balkútan*.

akkúb: Cover, wrapper. *Akkúb* and *abbóñg* may sometimes be used interchangeably. If not, only daily use can teach the student which of the two has to be used in any particular instance. However, *abbóñg* is confined to cloth, paper, and similar material, and emphasizes the concept of "protecting;" while *akkúb* is a more general term and emphasizes the concept of "covering." The cloth that envelops a little babe, when it is taken out of doors, will be called *abbóñg;* a tablecloth is either *abbóñg* or *akkúb;* a pillowcase, the wrapper of a book, and the like, are *akkúb*. *Kalúb* is another name for "cover," and differs from *akkúb* in that it is the cover that rightly belongs to the object in question, for instance, the lid of a trunk, the earthen cover of an earthen jar, the eyelid, and the like, while *akkúb* is a cover for the time being, not forming a whole with the object it covers, for instance, a piece of wood, a stone, or a similar object used to cover a jar, for example. Cf. also *ap-áp*.

akló: Ladle. A spoonlike wooden instrument used to extract cooked food from a jar, a kettle, or some other cooking vessel. It is generally of one piece, consisting of a relatively long handle with a kind of blade much broader than the rest. The *akló* either is entirely straight (the rice ladle) or has a curved blade (the vegetable ladle). Cf. *sódo*. The scapula, or

[1] Philip. Journ. Sci. 62 (1937) 67.

shoulder blade, is called *ak-akló* or *akloakló*.

alát: A kind of basket made of close-woven bamboo. It has the form of a cylinder and is usually about 20 inches high and about 6 inches in diameter. Salt is generally kept in and sold by the *alát*.

alíli: Either of the two wooden handles of the Iloko bellows. Cf. *yubuyúban*. (Plate 2, fig. 11, *c*.)

allúd(an): A kind of basket resembling the *rañgáya* in all its particulars, but smaller. The *allúdan* is larger than the *labbá*.

al-ó: Pestle. The Iloko pestle is a single rounded piece of wood, cut out in the middle so as to be easily grasped and kept in the hand by the user. Generally either of its two ends may be used indifferently. Cf. *alsóñg*. (Plate 1, fig. 1.)

alsóñg: Mortar. The Iloko mortar is a strong, heavy, mostly cylindrical piece of wood, or occasionally stone, scooped out in the center so as to form a hole, which is deep and comparatively narrow, except at the top, where it is gradually widening from below upwards. It is used chiefly for husking rice that has been threshed. Rice is threshed on the floor or in heavy logs scooped out in the shape of a boat (*kollóoñg*), and pounded or husked in the mortar by means of the *al-ó* or pestle. Generally only one person pounds rice in the mortar, but occasionally two or even three persons, each of them provided with a pestle, work together pounding the rice alternately. In case there are three, each person alternately pounds the rice and drops the pestle on the broad rim of the mortar, so that the rhythm of the performance continues unbroken.

(in)anaáw(an): A kind of *kattokóñg* hat made of the limbs of the leaves of the *anáaw* palm (*Livistona rotundifolia*). The *inanaáwan* sometimes reaches a diameter of one yard.

anáwañg: A kind of underground furnace used in the preparation of sugar from the juice of the sugar cane (Plate 1, fig. 2). It consists of four holes dug in the ground in a single file and communicating with one another. The foremost hole and the third are dug straight down, while the second and the last are slanting toward the third. The foremost hole or (*pag*)*kadkád*(*an*) (*a*) is the largest and is used to rake out the ashes; the second or (*pag*)*suñgrúd*(*an*) (*b*) is used to feed the fire, generally with dried bagasse; the third or (*pag*)-*saáñg*(*an*) (*c*) forms the real furnace and is covered by the large iron pot or *s*(*in*)*ublán*, into which the juice is poured; the fourth or *samborión* (probably of Spanish origin) (*d*) serves as a chimney.

annañgá: A kind of raincoat made of palm leaves (generally of the *anáaw*, *Livistona rotundifolia* Mart.), whose bases surround the neck of the wearer and whose tops spread like a fan all around the body except in front, at the height of the waist line. Ordinary raincoats are known by their Spanish name *capote*.

áñgat: A plow with a mat or lusterless share and moldboard. Cf. *siláp*.

añguyób: Blowpipe; usually a section of bamboo consisting of several internodes. Also: either of the two iron tubes of the Iloko bellows through which the air is expelled into the fire. Cf. *yubuyúban*. The windpipe or trachea is called *añg-añguyób*. (Plate 2, fig. 11, *b*.)

ap-áp: Cover, wrapper; layer, stratum, litter, bedding. Anything that is used to cover something, and on which, in turn, something else is placed or on which some work is done. It serves as a kind of protection either for that on which it is laid and against that which is done or laid upon it, or vice versa. Examples are: the saddle cloth, the layer of straw or hay that is laid in a hen's nest, the leaf or paper spread in a basket before meat, or some other food is placed in it, and the like. A pillow on which bobbin lace is made has two covers: a lower one or *ap-áp*, which covers the pillow immediately and over which the lace is made; it prevents any dirt that might be shed by the stuffing of the pillow from affecting the lace; an upper one or *akkúb*, which covers the whole outfit; it prevents outside dirt from affecting the lace. Cf. *akkúb* and *ápin*.

ápin: Any kind of leaf or leaves spread over the bottom of a *báñga* or earthen pot, at the inside, before the rice that has to be cooked is poured into it. The most ordinary *ápin* is a piece of banana leaf. Cf. *ap-áp*.

(pag)apúg(an): A kind of very small *báñga* or earthen jar used by chewers of betel nut for holding lime. Literally: a receptacle for lime; *ápug* means "lime," the combination *pag . . . an* is a locative. Hence: any receptacle for lime.

(pañg)arun(án): Anything very inflammable or taking fire easily, for instance, paper, pitch pine, shavings, etc., and used for starting a fire. From the stem *arún* and the locative *pañg . . . an*.

(pañg)asá(an): Whetstone, oilstone, hone. From the stem *ása*, "whetting," and the locative *pañg . . . an*.

asád: A kind of agricultural fork: a wooden implement consisting of a handle with a small board provided with several prongs or tines, which are parallel and straight; it is used, like a dibble, to make holes in the ground in order to sow rice. Rice is sown (*agbonóbon*) in plots of ground carefully prepared for the purpose, before it is transplanted (*agraép*) into the rice fields. Imported forks, either agricultural forks or table forks, are known by their Spanish name *tenedor*, pronounced *tenidór*. (Plate 1, fig. 3.)

(pag)asin(án): Saltcellar. From the stem *asín*, "salt," and the locative *pag . . . an*.

assíw: Any kind of pole, mostly of wood or bamboo, used for carrying loads on the shoulder. More exactly: the pole used by a single carrier both parts of the load having been equally divided between both ends of the pole, and the latter's central part resting on the carrier's shoulder. Cf. *(paginn)assiwán*.

(paginn)assiw(án): Any kind of pole, mostly of wood or bamboo, used for carrying a heavy load between two persons, either extremity of the pole resting on the shoulder of one of the carriers. The combination *pag . . . an* is a locative; the infix *inn* indicates reciprocity, rivalry, etc. Cf. *assíw*.

badáñg: A kind of *bunéñg* or bolo with a pointless blade, shorter but much broader than that of the common *bunéñg*.

(pag)bagas(án): Any receptacle for husked rice, for instance, a *karámba* or earthen jar, a wooden box, or the like. Except on special occasions, such as banquets, the Iloko never pound a great quantity of rice all at once, as

it tastes much better when freshly pounded; hence the quantity of pounded rice that has to be stored away is generally small. *Bagás* means "husked rice;" the combination *pag . . . an* is a locative.

bagiñgét: Pincers, nippers.

(kaba)bái: The smaller of a pair. For instance: the shorter of the two rollers of a cane mill (Plate 1, fig. 5, *a*), the shorter of the two handles of a *sáyot* (a kind of scoop net). Cf. (*kala*)*láki*. *Bái* means "female;" *babái*, "woman;" the prefix *ka* forms nouns, more especially abstract nouns.

bakí: Nest. Any receptacle prepared by man for hens in which to lay their eggs and to hatch their young. An ordinary bird's nest is called *úmok*. The typical *bakí* is an open-worked basket with a flat square bottom and a round rim.

bakká: A kind of earthen basin, used especially for washing and cleaning rice, fish, vegetables, and the like. Ordinary basins are known by their Spanish name *palangana*.

baláis: A bamboo attached on one side to the main roller or *kalaláki*, and on the other side to the shaft or *tañgbáw* of a cane mill. The purpose of the *baláis* is to strengthen the shaft. (Plate 1, fig. 5, *d*.)

balkút(an): Wrapper. *Balkútan* and *abbóñg* may sometimes be used interchangeably. However, *abbóñg* emphasizes the concept of "protecting," while *balkútan* is a more general term and emphasizes the concept of "wrapping up, more or less completely;" hence, *balkútan* will rarely be used with reference to living beings. From *balkút*, "wrapping," and the locative suffix *an*. Cf. also *akkúb*.

banbán: A kind of *kattokóñg* hat made of strips of *púser* bamboo (*Schizostachyum fenixii* Gamble).

bandíli: A fine-toothed saw with a narrow blade and without frame. The *bandíli* is simply the blade of a frame saw.

banílag: A shelf made of woven bamboo and attached to one of the tiebeams of the kitchen, in order to hold utensils and other things of use in the kitchen. Cf. *kaláwag* and *dayóday*.

bantéñg: Line, clothesline. A rope, a strip of bamboo, a wire, or the like, stretched between two fixed objects for the purpose of holding things that have to be dried, or to be exposed to the sun. Cf. *partéñg* and *salad-áyan*.

báñga: A broad-mouthed, almost spherical, vessel of earthenware with a round bottom, used for cooking rice. In well-regulated kitchens, the real *báñga* serves no other purpose. (Plate 1, fig. 4.) Other earthen pots or jars: (*pag*)*apúg*(*an*), *burnáy*, *dońgdóńg*, *gambóñg*, *kam-áw*, *karámba*, *táyab*, *putík*. Kettles are known by their Spanish name *caldero*.

báñgad: Back (of a knife, a saw, or similar implement). Cf. *tadém*.

(pag)barút(an): A tool used by silversmiths to thin silver bars. It consists of a bar of iron, some 8 inches long, and pierced with a series of holes gradually decreasing in size. The sharpened silver bar is pushed into and pulled by means of pliers through each hole in succession, until it acquires the required size. *Bárut* means "wire;" the combination *pag . . . an* is a locative.

basíkaw: Hoop. Made of wood.

(maysa a) bassít: ½ centavo piece. A small copper coin used in Spanish times. Literally: one small one.

batáy: Stand, support. Something on which anything may be placed for support, for instance, a contrivance of wood or bamboo on

which jars, especially *karámba*, are placed; stones or pieces of wood on which timber is placed to prevent the latter from coming in contact with the ground and being destroyed by white ants.

báut: Stick. A slender piece of wood, much thinner than the *pañg-ór*, used for whipping.

bayeñgyéñg: A thick section of bamboo, consisting of several internodes and used for carrying liquids, rice, or some other burden; more especially, water. Cf. *potóñg*.

beñgbéñg: Curtain. Any kind of cloth used as a hanging screen and intended to darken, conceal, protect or be ornamental, usually admitting of being drawn back or up at pleasure, for instance, when there is a sick person in the house and he cannot have a separate room, a movable screen for concealing the stage, pieces of cloth used to ornament the stage, the altar, or for similar purposes. A mosquito net is called by its Spanish name *mosquitero*.

bettád: A kind of sledge or sledge hammer, with a head about twice as large as the *doñgsól* or ordinary blacksmith's hammer.

bettėk: Band, tie, string. A strip of bamboo, a vine, or the like, used to bind reaped rice into bundles.

bigáo: Winnow, winnowing basket, or fan. The *bigáo* is woven closely, rather large, very shallow, and oval in shape, with one end broader than the other; it is used to winnow pounded rice.

bintíñg: The weight of twenty-five copper 1-centavo pieces. A silversmith's term. *Bintíñg* also means "a value of 25 centavos."

(bitin)bítin: Either of the scales or pans suspended from a balance. *Bítin* means "suspending;" the reduplication indicates similarity or repetition of an action.

(pam)ugbúg(an): Any receptacle (a *báñga* jar, a can, or the like), used for holding remnants of food, parings, water in which rice has been washed, or whatever may be used as food for hogs, dogs, and other domestic animals. *Bugbúg* means "reducing to pulp;" the combination *pañg . . . an* (final ñg of prefix combined with initial b of stem into m) is a locative.

buligengén: A small basket resembling a *yakayák* sieve, but closely woven like the *bigáo* winnow, and used for holding small objects for sale, for instance, small bundles of ready-made betel nut.

bunéñg: Bolo. A kind of large, single-edged knife, resembling a machete, which is a large heavy knife resembling a broadsword, often two or three feet in length. Cf. *badáñg*.

burnáy: A kind of vase or jar, a deep strong broad-mouthed vessel of earthenware, rounded, with a flat bottom, and usually of greater depth than width. It is commonly used to hold water for cleaning purposes, but several commodities, as sugar, *bási* (an alcoholic beverage made from sugar cane), and the like, are very often sold by the *burnáy*. (Plate 1, fig. 6.) Cf. *báñga*.

buyúbuy: A kind of cup, which consists of about one-half or two-thirds of a coconut shell, thoroughly cleaned and fit to be used as a dipper, a drinking cup, or for a similar purpose. In some districts it is called *óñgot*. Cf. *dúyog*. Ordinary glasses are known by their Spanish name *vaso*, pronounced *báso*.

dagsén: Weight, as a definite mass of iron, used for ascertaining the weight of other bodies.

dalikán: Hearth. Any kind of hearth; more especially: a portable earthen contrivance, more or

less in the shape of a cradle, with a flat bottom, and three hornlike projections (*pagsaáñgan*) at one end, upon which are placed the jars used in cooking; the other end (*dapogán*) forms a receptacle for ashes.

damortís: Cf. *lótiam.*

(da)dapíl(an): Sugar mill. A machine with rollers for pressing out the juice of the sugar cane; it is generally moved by a carabao attached to the end of the *tañgbáw* beam and walking in a circle. (Plate 1, fig. 5.)

dapó: Ashes.

dapogán: The part of the *dalikán* or hearth adjoining the *pagsaáñgan,* and used as a receptacle for ashes. Derived from *dapó.*

darusdús: A kind of thrust hoe, scuffle hoe, or Dutch hoe, used for weeding. The *darusdús* is straight and consists of a wooden handle, between one and two feet long, and a flat, comparatively broad iron blade.

dayóday: A contrivance of wood, bamboo, or similar material, set horizontally on a wall at a distance from the floor, to hold mats (*ikamén*), pillows (*puñgán*), and other bedding. The *dayóday* either forms a shelf or consists of two or more bars projecting from the wall at a certain distance from one another.

dikén: Pad. A circlet, made of cloth, and used by women to place on their head when carrying a load, in order to steady the latter and to avoid its immediate contact. The central space of the *dikén* is smaller than that of the *sagapá.*

(pa)díla: The end of a wooden haft, handle, or helve that fits in an iron socket (Plate 2, fig. 10, *c*). *Díla* means "tongue," the prefix is an instrumental.

(pa)dná: A piece of rope with one end fixed in the nasal septum of a carabao and the other attached to the rope proper. The *padná* is much longer than the (*pa*)*sóñgo* and passes beyond the animal's horns. From the stem *dinná,* "adjoining," and the instrumental prefix *pa.*

diñgdíñg: Moldboard (of a plow). The moldboard and the share (*subsúb*) are the only pieces of an Iloko plow that are made of iron, all the rest is made of wood. (Plate 2, fig. 10, the moldboard does not appear.)

doñgdóñg: A kind of very large *báñga,* used for cooking rice, stewing meat, and for similar purposes.

doñgsól: Blacksmith's hammer. Cf. *bettád.* Ordinary hammers are known by their Spanish name *martillo.*

dúlañg: Table. Native tables are very low, and persons sitting at them cannot use chairs but must simply squat or sit on the ground and occasionally on a small low stool. Ordinary tables are called *lamisáan,* from the Spanish *la mesa,* "the table", and the locative suffix *an.*

(pa)dúlañg: Pulverizer, a device for pulverizing the soil. *Dúlañg* means "table," the prefix is an instrumental.

dúyog: A kind of saucer or small dish, which consists of about one-fourth of a coconut shell, thoroughly cleaned and fit to hold viands (not rice), condiments, and the like, at meals. Rice is placed in wooden plates called *látok,* one for each individual. Cf. *buyúbuy.* Ordinary saucers are known by their Spanish name *platito.*

gabión: A kind of grub hoe, chiefly used to dig the ground.

gadgád(an): A kind of rough whetstone, used to smooth spindles, and for similar purposes.

gálut: Cf. *singdán.*

gambóng: A kind of large *karámba,* about three or four times as large as an ordinary one.

garugád: File.

gerrét: A kind of blacksmith's chisel with a long handle, used for grooving hot iron. The *gerrét* is driven by a hammer.

gesgés: A kind of heavy lumbermen's two-handed saw, used for felling trees. Its blade has the same width all along and its teeth point in an opposite direction on both halves of the blade. Cf. *kíkir* and *ragádi.*

getténg: Scissors, shears. Cf. *kartíb.*

gíbak: Potsherd. A piece or fragment of a broken earthen vessel, like a *bánga* or *karámba.* A *gíbak* is much thinner than a *ríbak.*

gilíng(an): Corn mill. Two flat stones used for grinding Indian corn by rubbing and crushing; the lower stone lies on the ground and the upper one is provided with a handle.

íbeng: The main body of the Iloko bellows into which the air is drawn: it consists of a hollow piece of earthenware resting on the ground and provided at one of its sides with two iron tubes or *anguyób* through which the air is expelled into the fire. The two hollow cylinders through which the air is drawn into the *ibeng* rest on the latter's upper surface. Cf. *yubuyúban.* (Plate 2, fig. 11, *a.*)

ígad: Coconut scraper. An instrument used for scraping out the meat of coconuts. It generally consists of a heavy block of wood resting on the ground or preferably on the edge of a chair and provided with an upward projection terminating in a toothed iron blade.

ikamén: Mat. A coarse fabric made by weaving strips of the leaves of the screw pine (*Pandanus* sp.), strips of the petioles of the *sílag* or buri palm (*Corypha elata* Roxb.), or similar material, and universally used to sleep upon. On arising it is rolled up together with pillows and blankets, and placed on the *dayóday.* Beds are known by their Spanish names *catre, cama.*

imokó: Knife. The *imokó* is a diminutive *bunéng.* Ordinary knives are known by their Spanish name *cuchillo.*

ingát: Toothpick.

(pa)ípit: Vise; for instance, the carpenter's wooden vise, the parallel swivel bench vise. *Ipit* means "chela" or "pincers of crustaceans," the prefix is an instrumental.

(pag)kadkád(an): Ash pit. The part of the *anáwang* furnace where ashes are collected and whence they are ultimately drawn to be thrown away. (Plate 1, fig. 2, *a*, a_1) *Kadkád* means "raking embers;" the combination *pag . . . an* is a locative.

kaláwag: A shelf made of timber or bamboo, to hold dishes. Cf. *banílag* and *dayóday.*

kallogóng: Hat. A general term. Cf. (*in*)*anaáwan, banbán, kattokóng,* and *kopía.*

kaluát: A kind of tray generally made of woven bamboo or rattan and suspended from the ceiling, the roof, or a *bekkér* tiebeam, to keep articles of food out of the reach of rats, cats, dogs, etc.

kalúb: Cover, lid. Cf. *akkúb.*

kalúb(an): Sheath, scabbard. A wooden case for a *bunéng* or bolo. The *kalúban* generally covers the

blade of the *bunéñg* completely on both sides.

kalúlot: Ferrule. A metal ring covering the end of the hilt of a bolo, a knife, or a similar implement, where the tang of the blade is inserted.

kam-áw: A kind of very broad-mouthed rather strong earthen vessel, resembling an ordinary flower pot and almost identical with the lower half of a *burnáy;* it is chiefly used for holding lard.

kammadáñg: A kind of baboosh or babouche with a thick wooden sole and a comparatively high heel, used in rainy weather. The ordinary baboosh, which is a kind of Oriental slipper without heel or quarters is known by its Spanish name *chinela.*

karámba: A board-mouthed earthen vessel, very much resembling a *doñgdóñg báñga,* and used to hold water for drinking purposes.

(pagka)karambá(an): A stand or support for *karámba* jars, usually made of woven rattan. The combination *pag . . . an* is a locative, and the reduplication emphasizes the meaning.

kartíb: Scissors, shears. Cf. *gettéñg.*

karuás: A kind of skimmer. It resembles an ordinary vegetable ladle (cf. *akló*), but, instead of being provided with a wooden blade, it has one made of open-worked woven rattan or bamboo.

kárus: Scraper. Anything that can be used to scrape out the meat of coconuts, or to scrape papaws or papayas into shreds for salad; for instance, a potsherd, a piece of a coconut shell, etc. The *kárus* is larger than the *kirús.* Cf. also *ígad.*

katám: Plane, joiner's plane; for instance, the wooden jack plane, or the wooden trying plane.

kátoy: A kind of small silversmith's hammer with a head made of horn.

kattokóñg: A kind of hat, either consisting of the outer shell of the rounded part of a bottle gourd, or woven from strips of bamboo, from rachises of climbing ferns (*Lygodium* sp.), or the like. Its upper surface is rounded throughout, and the crown is not differentiated from the brim; consequently the *kattokóñg* more or less resembles an overturned basin. It fits the head by means of a folded band (*liñgká*) of woven rattan, bamboo, or the like, placed inside at the center, and it is usually kept in place by means of a chin strap (*paratímid*). Cf. *kopía.*

kaykáy: Outdoor broom. Any contrivance used to sweep houseyards, streets, etc. Cf. *ságad.*

kelléb: A cover for an earthen jar, *báñga, karámba,* and the like. The *kelléb* consists of a perforated section of a coconut shell (*surúsur*) provided with a wooden knob at the center of its convex side, which remains uppermost. Cf. *kalúb.*

kíkir: Saw. Any kind of saw that can be handled by a single person, for instance, a ripsaw or a small frame saw. Cf. *gesgés* and *ragádi.*

kiráod: Any cuplike implement used to draw rice, liquids, or other substance from a receptacle; for instance, a cup, a can, or a tin. This term is chiefly used as a measure (*sañgkakiráod,* "one cupful"), and more or less corresponds to the Spanish *chupa,* the eighth part of a *salúp* or *ganta* (three liters). A *kabán* (Spanish *caván*) holds 25 *salúp* or 75 liters.

kirús: Scraper. Anything that can be used to clean a pot, a pan, or other utensil to which some ex-

traneous matter is sticking; for instance, a potsherd or a piece of coconut shell. The *kirús* is smaller than the *kárus*.

kollóoñg: Trough. A large vessel, long and comparatively shallow, used to hold fodder for swine. It generally consists of a heavy log, hollowed out in the shape of a boat. A somewhat larger *kollóoñg* is used to separate rice from the stalk by means of the *al-ó* or pestle, before it is pounded in the *alsóñg* or mortar. The same name is actually applied to the crib or manger in which Jesus was laid in the stable at Bethlehem.

kompáñg: The receptacle of the *saíñgan* lamp. Also: a small receptacle made of heavy bamboo and used by silversmiths to hold metals that have to be melted; in order to obtain this result the operator blows fire over the metal in question.

kompáy: Sickle. The *kompáy* has a toothed blade.

kopía: A hat with a crown and brim, made of woven strips of the petiole of the *silag* or buri palm (*Corypha elata* Roxb.). Cf. *kallogóñg*.

koppít: A kind of *upít* basket, used to hold provisions, implements, and the like. It differs from the ordinary *upít* in being about twice as high. *Koppit* also means "flat, flattened."

koribatóñg: Plumb bob, plummet. Cf. *tinnág*.

kotkót: Grooving plane, rabbet plane.

kulúkul: Gimlet, auger.

kuríbut: A kind of basket similar to the *alát*, but much larger, sometimes more than one yard high. It is used for holding salt, cotton, and the like.

labbá: A kind of basket with a square bottom and a round rim. The *labbá* resembles the *rañgáya* in all particulars, but is much smaller, its diameter at the rim being generally less than one foot. As this is perhaps the most common basket known by the Iloko, *labbá* is often used as a general term for all baskets.

ladáwan: Image, statue, picture, portrait, print, photograph, painting.

(kala)láki: The larger of a pair. For instance, the longer of the two rollers of a cane mill, the longer of the two handles of a *sáyot*. Cf. (*kaba*) *bái*. *Láki* means "male;" *laláki*, "man;" the prefix *ka* forms nouns, more especially abstract nouns. (Plate 1, fig. 5, *b*.)

lálat: Leather.

(pag)laná(an): Oiler, oil can. *Lána* means "coconut oil;" the combination *pag . . . an* is a locative.

lánañg: Solder.

lañgdét: Chopping block. It usually consists of a thick board of hardwood.

(laput)lapút: Automatic hand drill. The Spanish term *barrena*, for any kind of drill or brace, is used much more extensively.

látok: Wooden plate. Only rice is eaten from the *látok*. Cf. *dúyog* and *piñggán*.

lídiñg: Ring. For instance, a ring of bamboo or coconut shell that is fixed in the nasal septum of a carabao and to which the rope is attached, a metal ring fixed in the snout of swine to keep them from digging up the ground, or the like.

lidlíd: Polishing iron, burnisher. The *lidlíd* of the Iloko silversmith is simply a curved piece of wire; it is dipped in a mixture of soap and other ingredients before it is used to burnish precious metals that have been previously smoothed and polished with a file.

likídan: A kind of rolling pin, consisting of a cylindrical piece of wood, about as big as a finger,

and used by silversmiths to roll metal into cords or strings. The *likídan* is repeatedly pushed over the metal, away from the operator.

líkup: Scooper. A chisel with a scooplike blade.

línas: Cf. *siñ̃gdán.*

liñ̃gáliñ̃g: A kind of portable screen, consisting of a large sheet of woven bamboo, and used by harvesters to cut off the rays of the sun. It rests on the ground with one end and is kept upright in a slanting position by a prop, generally a bamboo.

liñ̃gká: A band of woven rattan, bamboo, or similar material, fixed in the center of the *kattokóñ̃g* hat, at the inside, to fit the head of the wearer. This band is folded and turned into a ring of the desired size; both its borders are applied to the hat, while the convex side remains undermost and next to the head of the wearer.

(pa)ltík: A kind of marking line consisting of a long string covered with wet soot and used by sawyers and carpenters to mark timber. This string is terminated at one end by an iron point (generally fixed in a small wooden handle), which is driven in the log or piece of timber a little below the surface that has to be marked, while at the other end it is pressed by the operator against the same surface usually with the index of his right hand; then with the hand that remains free the stretched line is lifted up somewhere at the center and immediately allowed to fall down again into its normal position, once, twice, or oftener, until it leaves a straight black mark all along. This string is generally attached to a kind of pulley consisting of a piece of wire and kept in the back compartment of a double wooden boxlike contrivance without lid, a small wooden handle being fixed to the same pulley at the outside through a hole in the side of the box. After the marking is done the operator turns the handle in order to wind the string on the pulley inside the box, where it first passes through the front compartment, in which is stored some coconut husk saturated with soot. The string passes through two holes, one in the front side of the box, and one in the partition, whenever it is wound or unwound, but the aforementioned iron point keeps it from passing through completely when it is wound up. The string is blackened most effectively by pressing it lightly against the coir in the front compartment of the box with a small stick, whenever it is unwound for a new marking. From the stem *littík,* "hole in a jar," and the instrumental prefix *pa.* (Plate 2, figs. 7 and 8.)

lótiam: A mold used by silversmiths for a kind of ear pendant called *damortís.* The *damortís* is a tree (*Pithecolobium dulce* Benth.), and also the fruit of this tree, namely a large, turgid, curved, mostly spiral pod, the shape of which is reproduced in the aforementioned ear pendant. This term is probably not genuine Iloko.

lúbid: Cf. *siñ̃gdán.*

mallokóñ̃g: A very large earthen cup without a handle.

málo: A kind of wooden beetle for beating clothes that are being washed. The *málo* is entirely straight and hewn from a single piece of wood; its head is more or less oval-shaped and flat.

maysá a bassít: Cf. (*maysá a*) *bassít.*

(pag)nasnás(an): A piece of cloth, a towel, or a rag used to rub something; more especially: the rag on which a flatiron is rubbed before it is used to iron clothes. From the stem *nasnás*, "rubbing with a cloth," and the locative combination *pag . . . an*. Cf. *nisnís* and *(pag)punás(an)*.

nisnís: A piece of cloth, a rag, or the like, used to take hold of pots and pans over the fire, to wipe them when dirty, and for similar purposes. The *nisnís* is used to wipe objects that are liable to dirty it, while the *(pag)púnas* is used to wipe objects that will not dirty it, but only wet it at the most, for instance, washed plates, the body after a bath, etc. Cf. *(pag)nasnás(an)* and *(pag)punás(an)*.

óñgot: Cf. *buyúbuy*.

osáos: A small bowlike contrivance used by silversmiths to clean and polish rings, ear pendants, etc. The *osáos* consists of a small wooden arc with a string, attached at one end to one of the points of the arc, and loose at the other end. The string is first rubbed in a kind of dust obtained from smashed potsherds, and then the object that has to be polished is rubbed over the string. The silversmith takes hold of the free point of the wooden arc and of the free end of the string, with one hand, and with the other, he rubs the ring or other object to be polished over the string, up and down. In this manner most jewels are cleaned thoroughly, inside and outside.

otéñg: Tang, tongue. Of a knife, a bolo, or a similar implement.

padúl: The peg to which animals are attached by means of a rope. The *padúl* is stuck in the ground and the projection above ground is comparatively small.

paét: Chisel.

paíd: Fan. A small sheet of woven bamboo, a piece of cardboard paper, or the like, used for fanning the fire, in ironing clothes, roasting meat, and the like. Cf. *paypáy*.

palloká: Sandal. The *palloká* consists of a leather sole strapped to the great toe.

pandarás: Adz, carpenter's adz.

pandéñg: The vertical piece of wood that sustains the shaft or *tañgbáw* of a plow and rests on the *pután*. (Plate 2, fig. 10, *d*.)

pañg-ór: Club, cudgel.

pápag: A kind of bench or bed made entirely of bamboo. The legs and frame consist of round sections of bamboo; the seat or bed consists of woven bamboo or more commonly of more or less narrow strips of bamboo tied together (*inakílis*) with strips of rattan, like the *básar* or *datár* of the floor of the house.

paratímid: Chin strap. A rope or string attached to both sides of a *kattokóñg* hat and passing under the chin of the wearer. From the Spanish *para*, "for," and the Iloko *tímid*, "chin."

pariók: An iron pan with a round bottom and a short iron handle in the shape of a socket. Pans with flat bottoms are known by their Spanish name *sartén*, often pronounced *sartín*. Cf. *siliási* and *s(in)ublán*.

partéñg: Line. A cord, a wire, a strip of rattan, a bamboo, or the like, used in leveling and as a guide when making fences, roads, or the like. Cf. *bantéñg* and *rukód*. Probably from the instrumental prefix *pa* and some unknown root or stem (*rettéñg?*). *Irteñgén* means "to stretch."

pasnáan: Anvil. Probably from the locative combination *pa . . . an* and some unknown stem or root (*sána?*

not *senná*, as in this case the word should be accented *pasnaán*).

pátay: Cf. *batáy*.

patilambó: Platter. A large round plate or dish made of coarse earthenware. Modern platters are known by their Spanish name *bandeja* (sometimes called *bandehádo*).

páyon̄g: Umbrella, parasol.

paypáy: Fan. An instrument for cooling the person. Very often called by its Spanish name *abanico*. Cf. *paíd*.

pígad: Anything placed near an entrance to rub off dirt from feet or shoes; for instance, the husk of a coconut, corncobs, a mat, a rag, or a scraper.

piin̄g: A kind of pliers used to straighten the teeth of a saw. It consists of a piece of wire split at one end.

pin̄ggán: Plate. Any kind of plate except the *látok*.

pín̄gki: Flint and steel. For striking fire.

p(in)íwir: Old-fashioned ear pendants. The *piníwir* consists of a solid ring of precious metal with a gap that cannot be widened or shut.

porsisiáw: Silversmith's solder. Of doubtful Iloko origin. Cf. *lánan̄g*.

potón̄g: An internode of bamboo used for holding water, etc. Cf. *bayen̄gyén̄g*.

(pag)punás(an): Napkin. *(Pag)-púnas* means "towel"; for instance, a dish towel or a bath towel. Cf. *(pag)nasnásan* and *nisnís*. *Púnas* means "wiping;" the prefix *pag* is an instrumental; the combination *pag . . . an* is a locative.

pun̄gán: Pillow, cushion.

pután: Handle (of a knife), haft (of a sword), helve (of an ax), shaft (of a spear), shank (of a pipe), the part of a plow at the end of which is fixed the share, or the blade. (Plate 2, fig. 10, *e*.)

putík: A kind of small *burnáy*, whatever be its color and whatever its contents.

ragádi: A kind of large two-handed frame saw used for sawing logs. Its rather slender blade has the same width all along, and the teeth of each half of the blade point away from the center. Cf. *gesgés* and *kíkir*.

rakém: Reaper's knife. The *rakém* consists of a small wooden handle and a small blade stuck in crosswise at some distance from the top, with the back toward the handle. Plate 2, fig. 9. It is used to cut rice below the ear. The reaper takes hold of the *rakém* in the palm of his hand, with the index above and the three other fingers (thumb excluded) below the blade.

ran̄gáya: A kind of basket with a square bottom and a round rim. Like the *labbá* and the *allúdan*, the *ran̄gáya* is made of narrow strips of *púser* bamboo (*Schizostachyum fenixii* Gamble). The foot is surrounded by a strong broad strip of bamboo, while the border is pressed between two almost equally broad strips. All the rest is smooth and even, outside and inside. The *ran̄gáya* is at least twice as large as the *labbá*, and larger than the *allúdan*.

ríbak: Potsherd. A piece or fragment of a broken *burnáy*, *kamáw*, or the like; the same name is applied to thin bricks. The *ríbak* is much thicker than the *gíbak*.

(ag)rukíeb: To enter the ground, to be situated underground. For instance, all parts of the *anáwan̄g* furnace.

rukód: Line, rod; tapeline, tape measure, yardstick, meter. A cord, a wire, a strip of rattan, a bamboo, or the like, used in measuring. Cf. ***bantén̄g*** and ***partén̄g***.

(pag)saáñg(an): The support on which is placed a cooking vessel, like a jar, or a pan, when put on the fire; for instance, three upright stones, the three horns of a *dalikán*, the part of the *anáwañg* furnace over which is placed the *sinublán* pot. From the stem *sáañg*, "putting on the fire," and the locative combination *pag . . . an*. (Plate 1, figs. 2, *c*, c_1.)

(sa)sab-ít(an): Rack, peg, nail; hanger. Any projecting device to hold clothes or hats. Also: any of various hanging or depending devices for supporting something, as a chain, a rope, or the like, by which a lamp, a pot, or any object, is suspended. *Sab-ít* means "hanging," "suspending;" the suffix is a locative; the reduplication emphasizes the meaning.

ságad: Broom. An implement for sweeping floors. Cf. *kaykáy*. Common brooms are made of the panicles or tops of *buybúy* grass (*Thysanolaena maxima* O. Kuntze) bound together.

sagapá: Pad. A circlet, made of cloth, wood, straw, or the like, on which jars with a round bottom, for instance, a *báñga*, *karámba*, etc., are placed. Cf. *dikén*.

sagát(an): Strainer, filter, colander. The most primitive strainers consist of a piece of *sinamáy* cloth (made from the fiber of the *abacá* or Manila hemp). *Ságat* means "filtering" or straining; the suffix is a locative.

sagaysáy: Comb. Used for adjusting, cleaning, and confining the hair, or for adornment.

sag-út: Cf. *siñgdán*.

saíñg(an): Old-fashioned lamp. Any kind of small vessel (*kompáñg*) filled with oil in which swims an ordinary wick, made of twisted cotton yarn and resting on the rim of the vessel.

salad-áy(an): Anything on which something (clothes, etc.) is hung, to dry, for example, as a clothesline, or the back of a chair. Cf. *bantéñg*.

salapay(án): Cf. *salad-áyan*.

sallúy(an): A rope, a stalk of bagasse or the like, used to support and move long and slender objects by dragging them along the ground. The bagasse is generally moved that way.

sañggá: The collar or flange surrounding the base of the blade of a knife or bolo, and used to prevent it from entering deeper into the handle.

(pag)sañggá(an): Saucer. A small earthen dish in which a cup or a glass containing liquids is set. Cf. *sañggá*. The combination *pag . . . an* is a locative. Cf. *dúyog*.

(pa)saratsát: An implement of agriculture very much resembling a harrow, and formed of pieces of timber crossing each other and set with iron knives, usually sixteen, in four rows. It is drawn over land to cut tall weeds and grass, immediately before plowing. *Saratsát* means "disemboweling," "eviscerating," "unseaming," 'ripping;" the prefix is an instrumental.

(pag)sarmíñg(an): Mirror, looking-glass, speculum. From the stem *sarmíñg*, "glass," and the locative combination *pag . . . an*.

(agkai)sarombíñgit: Cf. *saroñggáñgat*.

saroñggáñgat: A small section of bamboo, about 2 inches long, with one end cut into sharp points all around, and strung on the rope of a carabao, between the terminal knot and the nose. When the driver pulls the rope the pointed edge of the *saroñggáñgat* pricks the nasal septum of the

animal. This device is used only with carabaos that are not easily manageable. *Agkaisaroñggáñgat* means "to lay around," "to be in a scattered position," "to be strewn all over the floor," etc., and is said, for instance, of garments, clothes, paper, thorns, or pins (on a pin cushion). *Agkaisarombíñgit* has the same meaning, but cannot be said of thorns, pins, or the like.

(pag)saruno(án): A long supplementary rope attached to the ordinary rope of a carabao, and used, for instance, in plowing, to direct more easily the movements of the animal. *Sarunó* means "following," "coming next;" the combination *pag . . . an* is a locative.

saud(án): A curved piece of wood resembling a *páko* or yoke, and attached to the fore end of a plow, at the end of the *tañgbáw* pole. Both *guyúdan* ropes are attached at one end to the real yoke and at the other end to the *saudán.* (The *saudán* is not marked in Plate 2, fig. 10).

saw-ít: A very small cup without a handle, used chiefly to measure *boggóong* (a kind of preserved fish, fermented and liquid).

sekkár: The *sekkár* is identical with the *kalúlot* except that it is made of woven strips of bamboo, and that it is also used to bind together the parts of a broom, or the like. Cf. *ságad.*

(pag)seldán(an): Any kind of vessel, as a *burnáy* or a large can, used to hold water for cleaning (not drinking) purposes.

sigpít: Clip. A clasp or holder for letters, or the like.

sikápat: Half a *bintíñg.* Cf. *bintíñg.*

sikawaló: Half a *sikápat,* one fourth of a *bintíñg.*

síko: Try-square. More often called *eskuála,* from the Spanish *escuadra. Siko* also means "elbow."

sikráoñg: A kind of large bag made of strips of heavy bamboo tied together (*inakílis*) with rattan, and used to carry *burnáy* jars, especially those filled with *bási* (an alcoholic beverage obtained from sugar cane). A pole is pushed through the *sikráoñg* over the *burnáy,* and the whole outfit is carried by two men.

siláp: A plow with a glossy share and moldboard. Cf. *áñgat.* A plow, in general, is known by its Spanish name *arado.*

(pag)siláw(an): Lamp. From the stem *sílaw,* "light," and the locative combination *pag . . . an.*

siliási: A kind of large iron pot with a round bottom. The *siliási* is identical with the *pariók,* except that it has no handle and that it has a diameter of from 2 to 3 feet at the rim. It is used for cooking meat in large quantities, for making lard, and the like.

siñgdán: String, attachment. A string, a vine, a strip of rattan, or the like, by which one thing is attached to another in order to prevent the former from running away or falling down. The *siñgdán* usually leaves a certain distance or space between both objects, while the *gálut* connects them immediately. The term *gálut* emphasizes the concept of "binding," while the term *siñgdán* emphasizes that of "attaching." Both *siñgdán* and *gálut* may consist of a string, a vine, a strip of rattan, or the like. The string or strip of rattan by which a hog, a rooster, or some other animal, is attached to a pole is called *siñgdán;* the string or strip of rattan by which the outer part of a shelf is attached to the wall

or ceiling is also called *singdán;* the strips of rattan that bind together the parts of a fence are called *gálut.* When the attachment that serves the purpose of a *singdán* is much thicker than a string, a vine, or a strip of rattan, it is called *talí,* for instance a rope, or a long strip of carabao hide. The *talí* may also serve the purpose of a *gálut,* but in this case it means "rope," to distinguish it from a *gálut* of other material or size: the rope of a horse is called *talí* (never *singdán*); the rope that binds together two heavy logs is called either *talí* (material) or *gálut* (use). Strings of smaller size than the *talí* are the *línas* or *lúbid* (string) and the *sinúlit* (thread); both may be used either as *singdán* or as *gálut* (the *sinúlit* is used more especially for sewing). The difference between the terms *línas* and *lúbid* is very slight, and they are often used almost synonymously, at least when the material is considered and before these strings serve a definite purpose. Strictly speaking the *lúbid* is finer and generally less strong than the *línas.* When these terms refer to strings that serve a definite purpose, leaving the material out of the question, the difference is much more emphasized: the *lúbid* more or less corresponds to the *singdán,* leaving a certain distance or space between two objects, while the concept of *línas* is nearer to that of *gálut.* The string by which a kite is attached or kept in the hand is called *lúbid* (never *línas*); the string used to keep together the contents of a package wrapped in paper is a *línas* (not a *lúbid*). *Sag-út* is cotton yarn used for weaving, and it may serve the purpose of both the *singdán* and the *gálut,* and also that of both the *lúbid* and the *línas.* Consequently: *singdán, gálut, talí, línas,* and *lúbid* refer to the purpose for which they are used; while *talí, línas, lúbid, sinúlit,* and *sag-út* refer to material or size.

Singdán: used to attach one thing to another, whatever its material, small size (for instance, a vine, or a strip of rattan; *línas, lúbid, sinúlit, sag-út*).

Gálut: used to bind, whatever its material or size (for instance, a vine, or a strip of rattan; *talí, línas, lúbid, sinúlit, sag-út*).

Talí: 1. (*a*) used to attach one thing to another, whatever its material, large size (a rope, a strip of carabao hide, or the like); (*b*) used to bind: rope.
2. rope.

Línas: 1. used to bind: string.
2. string, almost synonymous with *lúbid.*

Lúbid: 1. used to attach one thing to another: string.
2. string, speaking strictly, a little finer and less strong than the *línas.*

S(in)úlit: thread (for attaching, binding; more especially, for sewing).

Sag-út: cotton yarn (for attaching, binding; more especially, for weaving).

singsíng: Ring.

sípit: Tongs, forceps.

sobók(an): An iron bar used as a swage for shaping the *kalúlot* collar. The *sobókan* tapers toward an obtuse point and has four an-

gles, two of them sharp and two obtuse and a little rounded, so that a cross section would show a more or less lozenge-shaped figure.

sódo: A kind of ladle or dipper consisting of a cuplike section (mostly one half of a coconut shell) provided with a handle, and used to dip water. *(Pag)táko* is a general term for any hollow vessel used to dip liquids. Imported ladles made of earthenware are also called *pagtáko*, but sometimes, especially when taking the place of the *akló*, they are known by their Spanish name, *cucharón*. Ordinary spoons are called *cuchara*, teaspoons, *cucharita*.

sokl'ád: Spade, shovel, scoop. The blade is either wood or metal. The ordinary shovel is better known by its Spanish name *pala*.

(pag)sokog(án): Mold.

sonsíki: An iron bar used as a swage by silversmiths for flattening or evening the inner or outer surface of a ring, an ear pendant, or a similar object, that has become uneven, for instance, through inward or outward projection of one of its borders. The *sonsíki* has a deep narrow longitudinal groove at one of its ends; the object in question is thrust into this groove. This term is probably not genuine Iloko.

(pa)só n̄go: A piece of rope with one end fixed in the nasal septum of a carabao and the other attached to the rope proper. The *pasón̄go* is much shorter than the *(pa)dná*. From the stem *són̄go*, "snout," and the instrumental prefix *pa*.

suál: A kind of small spade or hoe used for digging and weeding. The *suál* is straight and consists of a wooden handle and a narrow iron blade of about one foot long, broadened, and flattened at the edge, where it takes more or less the shape of the end of an ordinary crowbar. The handle of the *suál* fits in the socket of the blade, while the blade of the *darusdús* generally enters the handle by means of a tang; besides, the blade of the *darusdús* is usually broad and flattened throughout, and its shape is very variable.

s(in)ubl(án): A very large *siliási* pot chiefly used for cooking the juice of the sugar cane.

subsúb: Share, plowshare. (Plate 2, fig. 10, *a*.)

(su)sudi(án): Touchstone, Lydian stone, basanite. *Súdi* means "luster;" the suffix is a locative; the reduplication emphasizes the meaning.

s(in)úlit: Thread. Cf. *sin̄gdán*.

(pag)sun̄grúd(an): The part of the *anáwan̄g* furnace into which the fuel is thrust. (Plate 1, fig. 2 *b*.) *Sun̄grúd* means "fuel," "feeding the fire;" the combination *pag . . . an* is a locative.

surúsur: A shallow vessel made of the part of a coconut shell which is perforated and through which the shoot finds its way when sprouting. The *surúsur* is used in the manufacture of the *kelléb*, and in washing the hair with a mixture of ashes of burnt rice straw and water, the strongest part of the ashes (too strong for the purpose) escaping through the hole or holes as soon as water is added to them.

(pag)suúr(an): A kind of large open-worked shelf or tray usually made of bamboo and suspended immediately over the fire. It is used to dry palay (rice), wood (fuel), etc. *Súur* means "smoking;" the combination *pag . . . an* is a locative.

taddó: A large round contrivance used for holding small objects, as rice, coffee, and the like, that have

to be dried in the sun. The *taddó* is identical with the *bigáo* winnow in every particular, except that it is completely round and usually much larger.

tadém: Edge. The cutting side of the blade of a knife, an ax, or a saw. Cf. *báñgad.*

tagay(án): Cup. Cups are better known by their Spanish name *taza*, pronounced *tása.*

takará: A shallow round basket, as big as an ordinary plate, and used for holding small objects of daily use, as betel nut, or bobbins. The foot of the *takará* resembles a *dikén* and is made of the ribs of the leaflets of coconut leaves; this foot is entirely different in shape, size, and texture from the rest of the basket, and both are woven separately.

takkúb: Cf. *akkúb.*

(pag)táko: Dipper. Cf. *sódo.* From the stem *táko*, "dipping," and the instrumental prefix *pag.*

talí: Cf. *siñgdán.*

tampípi: A kind of large rectangular basket with flat sides. The *tampípi* consists of two parts of unequal size, the larger one serving as a cover to the other, and is used to hold clothes, provisions for the journey, or the like. It takes the place of our trunks, but is much lighter and, consequently, especially suitable for traveling. Ordinary chests or trunks, made of wood or other material, are called *bául* (from the Spanish *baul*, "a kind of chest") or *lakása* (from the Spanish *la casa*, "the house"). Boxes are known by their Spanish names *cajón, caja, cajita*, according to their size.

tampók: Whatever is set in a ring, a scarfpin, or other trinket (the setting), as a gem or a pearl, whether precious or not.

tañgátañg: A kind of shelf, convex underneath, made of laths of bamboo tied together with strips of rattan, and used to hold jars, pans, and the like. The same term is sometimes applied to the *kaluát.* *Tañgátañg* also means "sky."

tañgbáw: Beam, shaft. Of a plow, or a sugar mill. The pole to which the animal is attached. The *tañgbáw* of a plow is sustained by the *pandéñg* (Plate 2, fig. 10, *b*); the *tañgbáw* of a sugar mill is fixed in the *kaláláki* roller (Plate 1, fig. 5, *c*).

táyab: An earthen vessel used for cooking fish, vegetables, or other food eaten with rice. The *táyab* is identical with the *báñga*, except that its mouth is much wider.

tenneb(án): A receptacle for holding water, used by smiths for tempering the edge of cutting instruments. It generally consists of either of the two parts into which a section of bamboo has been split longitudinally.

teppéñg: A kind of *dúyog*, used for measuring rice. Like the *kiráod*, it more or less corresponds to the eighth part of a *salúp* or *ganta* (3 liters).

tiáni: Pliers. The jaws of the *tiáni* are rounded.

timbeñg(án): Scales, balance (with two scales or pans).

tinnág: Plumb line. The plumb bob or plummet is called *koribatóñg.* *Tinnág* also means "falling."

tiñgál: A prop or wedge placed, for instance, under one of the legs of a table, to prevent it from moving.

tob-ók: A kind of blacksmith's punch, used for making holes in iron plates. The *tob-ók* consists of a stick of wood or bamboo with a sharp piece of iron attached sideways very near the top, in the same way as the blade of the *rakém* is attached to the handle. A sledge is used to drive the

iron of the *tob-ók* into the plate that has to be perforated.

toktók: A kind of iron hook, used for roughening whetstones. The *toktók* consists of a crooked bar of metal, about one inch thick, and pointed at the top. Repeated taps with this instrument all over the surface of the whetstone cover the latter with small indentations, which render it rough to the touch. *Toktók* also means "pecking (of birds)."

tombók: A kind of iron pestle used for shaping ear pendants, and the like, in a mold. The object in question is pounded in the (*pag*)-*sokogán* or mold by means of the *tombók*, until it gets the desired shape.

toól(an): Helve (of an ax).

tópia: The moplike part, covered with feathers, of either of the two wooden pestles of the Iloko bellows. The upper parts or handles, devoid of feathers, are called *alíli.* (Plate 2, fig. 11, *d.*) Cf. *yubuyúban. Topiáan* means "to fill up, to complete (a piece of cloth, a plot of ground, etc.)." To add (Plate 2, fig. 13, *a*) to the rest is called *topiáan.*

túdok: Spit. A slender pointed rod of iron for holding meat, fish, eggplants, and the like, while the latter are being roasted over the fire. *Túdok* also means "piercing."

tulbék: Key.

(pag)tuprá(an): Spittoon, cuspidor. *Tuprá* means "spittle;" the combination *pag . . . an* is a locative.

úgiñg: Charcoal, soot.

(pag)úgis: Marker. Any kind of instrument used in drawing lines, for instance a pencil, a chisel, or a diamond point. *Ugis* means "drawing lines;" the prefix is an instrumental.

upig(án): Cf. *tampípi.*

upít: A kind of basket with a flat rectangular bottom, usually slung from the shoulder, and used for storing provisions for the journey, tools, and the like. The *upít* consists of two parts unequal in size, the smaller one fitting exactly in the larger one, which serves the former as a cover. It is as long at the base as it is at the ridgelike top, but the larger sides, which connect the top with the base, gradually bulge out from above downwards until they reach the base, while the smaller sides are triangular (with apex at the top of the basket) and generally flat. (Plate 2, fig. 12.)

waláwal: A kind of dibble used to make holes in the ground, especially for making fences. It consists of a comparatively heavy pointed pole, which is operated with both hands, and repeatedly driven into the ground and moved to and fro with a more or less circular motion until the hole is large enough for its intended purpose.

wásay: Ax.

waywáy: A large thick supplementary rope, attached to the ordinary rope of an animal, in order to allow the latter more space for grazing.

weswés: A kind of iron broach used to pierce a hole in wooden handles, helves or shafts, in order to hold the tang of a knife, a spear, etc. The *weswés* has to be rendered red-hot before it can be used. The same name is applied to a child's toy, a kind of whirligig, consisting of a piece of a coconut shell or something similar, provided with two holes at its center and strung on a double rope which is held in both hands, one end of the rope in each hand. Both hands are moved successively to-

ward the piece of shell and away from it, in order to make it whirl around with a rapid movement and produce a whizzing sound.

witíwit: Plowtail. The handle of a plow. (Plate 2, fig. 10, *f*.)

yakayák: Sieve. The *yakayák* is a kind of round basket, open-worked at the bottom, but with very small meshes. It is usually smaller than the *bigáo* or winnow.

yubuyúb(an): Bellows. The Iloko bellows consists of a hollow piece of earthenware (*íbeñg̃*), resting on the ground, provided at one of its sides with two small iron tubes (*añg̃uyób*) through which the air is expelled into the fire, and surmounted by two large hollow wooden cylinders through which the air is drawn into the *íbeñg̃* by means of two pestles, whose lower ends (*tópia*) are covered with feathers, and which are moved up and down alternately, the operator taking hold of their handles (*alíli*), one in each hand. (Plate 2, fig. 11.) *Yubyúb(an)* means: to blow (the fire), whether with an *añg̃uyób* or blowpipe or with a *yubuyúban*.

ILLUSTRATIONS

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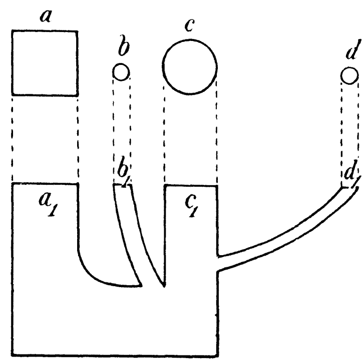

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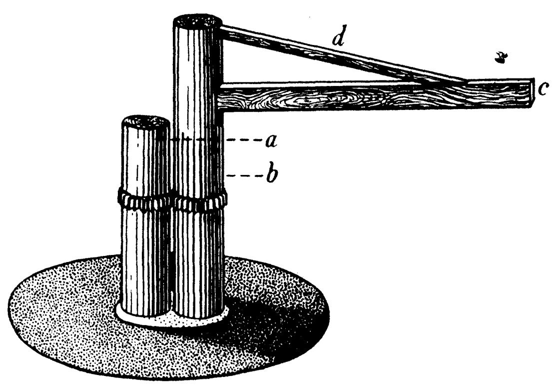

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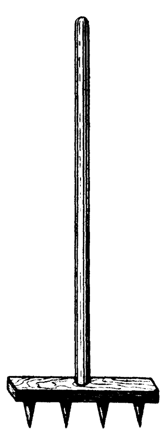

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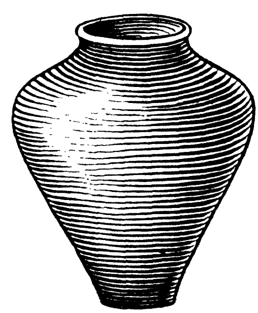

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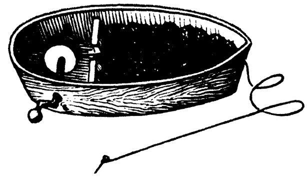
PLATE 1.



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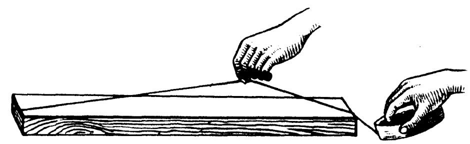

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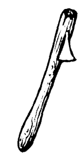

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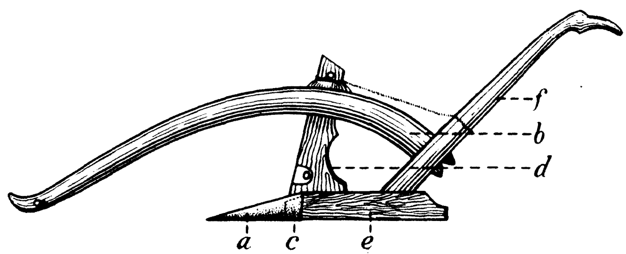

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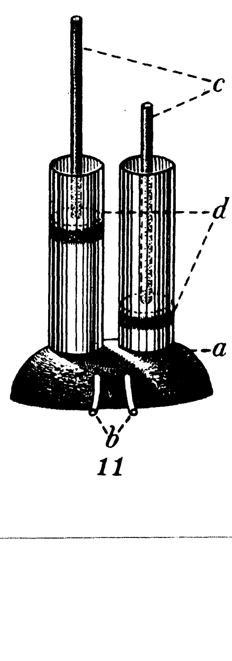

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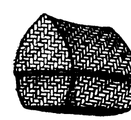

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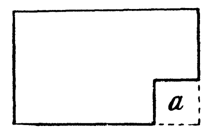

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PLATE 2.

THE GEOLOGY OF CALUBIAN AND VICINITY, LEYTE

By JUAN S. TEVES

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ONE PLATE

LOCATION AND EXTENT

The region studied is the northernmost part of the northwestern peninsula of Leyte, and covers an area of over 200 square kilometers. It lies between 11° 18′ and 11° 34′ north latitude and 124° 17′ and 124° 29′ east longitude.

The region is reached from Manila by way of Cebu, whence small boats sail almost regularly to either San Isidro or Calubian, towns on the western and eastern coasts of the peninsula, respectively. It may also be reached by plane from Manila via Iloilo, where another plane may be chartered to Tacloban, and thence by any of the boats plying between that town and Cebu to Calubian.

The present paper is based largely on the study of the region made by the writer in the summer of 1936, but the works of previous geologists were also consulted.

The northwestern peninsula of Leyte has been visited by several geologists. Pratt(3) made an exhaustive study of this part of the island, which forms the basis of succeeding geological investigations. Adams(1) explored the island in 1909, and studied the rock formations near Eulalia, now known as Calubian, preparatory to the drilling of artesian wells. Faustino(2) located favorable structures in the areas leased in the Banisilan Oil Company in the municipalities of Leyte, Palompon, and Ormoc, and also in the areas covered by the leases of the Union Oil Company in the vicinity of Calubian.

Inspite of the considerable geologic work done, exploration by drilling was not started until all the leases expired. Very little is known of the northernmost portion of the peninsula as the results of its geological studies have never been published.

Recently, more visits were made for exploratory purposes, and the area covered by oil leases in the island is greater than ever before.

FIELD WORK

The field work covered in this report was done in the latter part of the summer of 1936, over a period of almost one month. The United States Coast and Geodetic Survey Map No. 14 of Leyte was used as the base map. Investigation was made mostly along the creeks and rivers, where excellent exposures were found. Study of the coast also yielded valuable data.

PHYSIOGRAPHY

Most of the area under consideration is marked by rolling topography. The hills responsible for this configuration provide a moderate relief, which averages about 100 meters.

A ridge parallel and close to the eastern coast has an elevation of 313 meters on the south end, and gradually lowers northward to 187 meters back of Villahermosa. On the west are high discontinuous elevations running parallel to the coast. On the north is a cluster known as Mount Bunacan, and on the south is Mount Igang.

On the northwestern end of the peninsula is a limestone plateau which is terraced near the coast. The plateau is about 76 meters above sea level, and the terrace 30 meters.

There is no extensive plain in this part of Leyte. The alluvial plain back of the town of San Isidro and that of Villalon are the only ones of importance. The latter is surrounded by a semicircular arrangement of hills suggesting a cirque.

Two large streams drain the region—the Calubian and the Mataguk. Their courses are largely influenced by geological structure.

A hydrogen sulphide spring was located at Moroboro, and another was reported at Tuburan. There is a carbonated spring at Villahermosa, where a public bathhouse has been constructed.

ROCK FORMATIONS

The predominant rock formations in this area are sedimentaries—the limestones, shales, and sandstones. There are also some igneous rocks, mostly andesites.

Limestones.—The limestones may be classified into two zones, the upper and the lower zones. The lower zone is massive, hard, and fairly resistant to weathering. It is fossiliferous, consisting mostly of fossil corals, bivalves and other mollusks. This zone, from all appearances, seems to be equivalent to the Malumbang formation which in Philippine stratigraphy is considered of Pliocene age. The Malumbang formation seems to overlie the shales and sandstones of the Vigo without unconformity.

The other zone, which occurs in the northwestern part of the peninsula, is made up mostly of coral reefs, which extend into the sea. This zone is evidently very young and probably is equivalent to the Pleistocene in Philippine stratigraphy.

Shales.—The shales are very fine-grained and compact, breaking into small pebblelike particles and, very rarely, into thin laminæ. Their color varies from light to dark, slightly bluish, gray. They contain minute shells. The shales and the overlying sandstones described below may be equivalent to the Vigo formations which are classified as Oligocene in Philippine stratigraphy.[1]

Sandstones.—The sandstones are of varying texture, from fine- to coarse-grained. Their color varies from light gray to light brown. Some beds are calcareous and fossiliferous, while others are tuffaceous. They belong to the same series as that of the shales described above.

Andesites.—Andesite boulders were found at the mouth of a creek near Uson Point (Mataguk) on the eastern coast. They are fine- to medium-grained, and gray. Some of the boulders are light-colored and contain plenty of hornblende. Pratt(3) believes these intrusives to be "evidently younger than the Malumbang series if they are responsible for the dispersion of the bituminous matter which is observed to impregnate part of the Malumbang series, south of Villaba."

Andesite agglomerates were found east of the town of Leyte. The included materials are of varying sizes of angular andesite pebbles. The matrix is also of andesite, although of much coarser grains. These agglomerates answer the description of Smith's(5) Zamboanga formation and may be identical to it.

Recent deposits.—The recent deposits of alluvial material are found along the creeks and rivers and also along the coasts.

GEOLOGIC STRUCTURE

The sedimentaries are slightly arched, forming an anticline near and parallel the eastern coast of the peninsula. This upbowing may possibly be the result of igneous activity, as evidenced by the presence of igneous boulders at the debouchure of a creek near Uson Point, as already noted above.

The dips are gentle, being in general from 8° to 10°, although locally there are a few high-angled ones. The general trend

[1] These were regarded as Miocene until subsequent study led authorities in Philippine geology to assign them to the Oligocene.

of the strikes is northwest, and the axis of the anticline plunges also in that direction. The direction of the dips and strikes can be seen in the accompanying aërial geologic map. The thickness of the sedimentary formations is estimated to be no less than 1,000 meters.

Mount Igang, midway between Tagharigui and Tuktuk, on the southern part of the area, seems to be another intrusion, judging by the attitude of the badly broken sedimentary formations on its slopes.

A limestone plateau lies on the northwestern part of the area. It is terraced near the coast, the elevation being 30 meters. The plateau proper is about 80 meters. The plateau and terrace seem to indicate two periods of uplift.

A fault, trending about 30° northwest, occurs along the western limb of the anticline. Another smaller one joins this at about the southern end of the anticline. These faults are indicated by bold limestone cliffs, which are in perfect alignment with the fault lines and also by the presence of slickensides at Moroboro.

The sedimentary formations along the coast, from Calubian southward, and on the west bank of the Consuegra River, from Gotosan to Butason, dip northeast. The agglomerates at the back of the town of Leyte appear to be a flow over the sedimentaries.

ECONOMIC GEOLOGY

While no minerals of economic importance have been found and developed in this region up to the present, it has been known since the nineties to contain oil. Almost the whole area is covered by geological leases, and prospecting for this valuable commodity in commercial quantities is very active.

ACKOWLEDGMENT

The writer wishes to acknowledge his obligation to Mr. Quirico A. Abadilla, director of the Bureau of Mines, for suggestions and corrections in the presentation of this paper.

BIBLIOGRAPHY

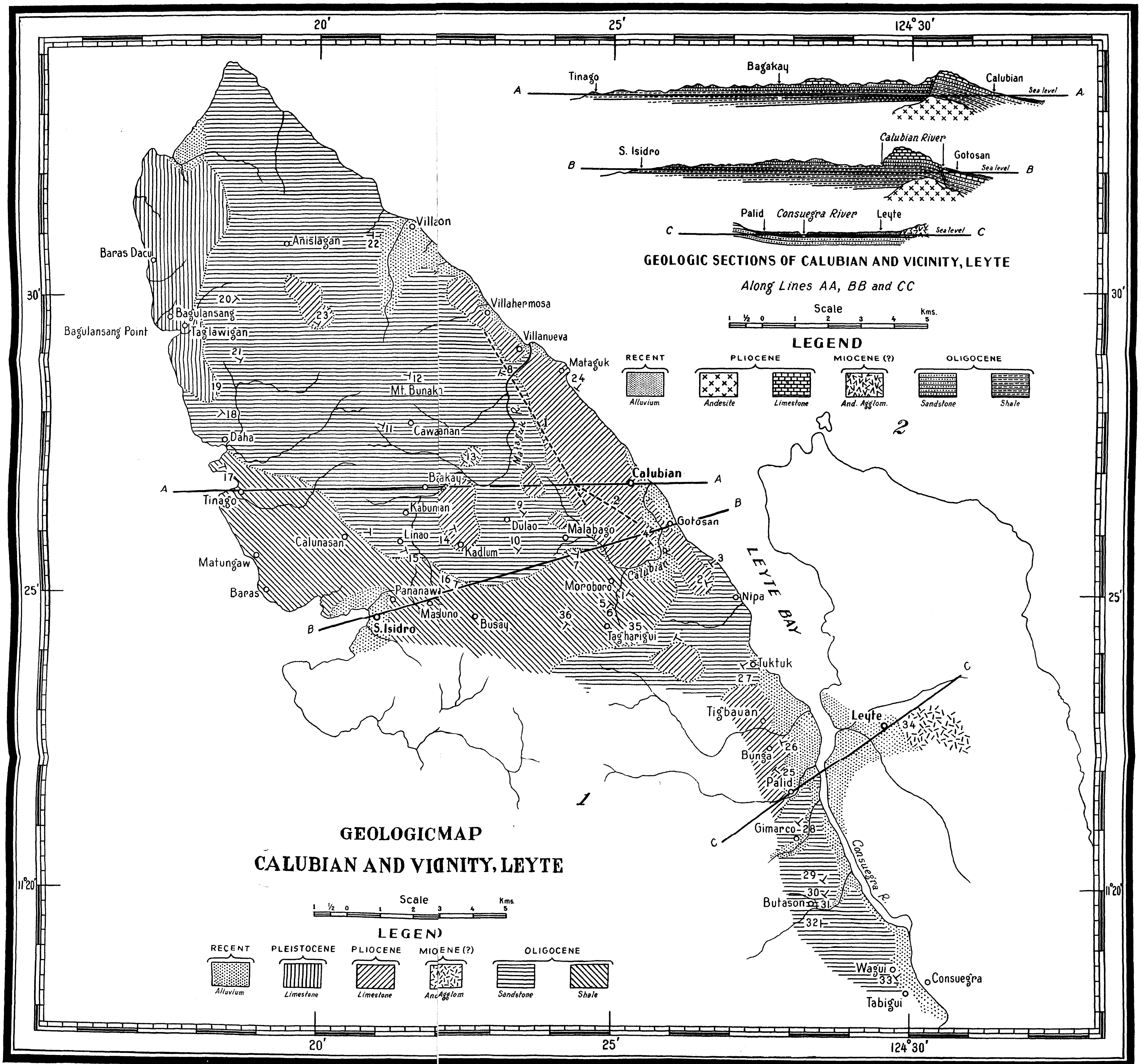
1. ADAMS, GEORGE I. Geological reconnaissance of the island of Leyte—with notes and observations in the adjacent smaller islands and southwestern Samar. Philip. Journ. Sci. § A 4 (1909) 339–358.

2. FAUSTINO, L. A. Petroleum and residual bitumens. Mineral Resources of the P. I. for the years 1921, 1922 and 1923 (1925) 41–46.
3. PRATT, WALLACE E. Petroleum and residual bitumens in Leyte. Philip. Journ. Sci. § A 10 (1915) 241–280.
4. Press Bulletin No. 42. Asphalt in Leyte. Bureau of Science. (1915).
5. SMITH, W. D. Geology and Mineral Resources of the Philippine Islands (1924).

ILLUSTRATION

PLATE 1

FIG. 1. Aërial geologic map of Calubian and vicinity, Leyte.
2. Geologic cross sections through lines *A-A*, *B-B*, and *C-C*.



Based on U.S.C.G.S. map No 14 Traced by F.G. Evaristo 9/36

SUBAËRIAL DIATOMS FROM SHANGHAI

By B. W. Skvortzow
Of Harbin, Manchoukuo

TWO PLATES

Several years ago I received from my friend and enthusiastic collector Mr. J. Kovalchuk-Koval a sample of mosses collected by him on the bark of a tree in Shanghai May 19, 1933. As during recent years a good deal of attention has been paid to the activities of diatoms of a subaërial nature, living in the soil, in mosses, on rocks, and on the bark of trees, I undertook the examination of this collection.

Subaërial diatoms belong to the aërophilous algæ, which are adapted to obtaining their water by absorption of atmospheric moisture and which survive the usually frequent dry periods, on which they are dependent because of their mode of living, without undergoing any particular resting stages. In the Shanghai sample I was able to distinguish 30 different diatoms, three of which are new to science. Compared on the basis of the present material, the flora of subaërial diatoms from Shanghai has a comparatively large number of species in common with that of Europe; namely, *Melosira Roezeana* var. *epidendron, Synedra ulna, Cocconeis placentula, Frustulia rhomboides* var. *saxonica, Navicula ignota, Navicula contenta* fo. *biceps, Amphora Normanii, Gomphonema gracile, Rhopalodia gibba, Epithemia zebra, Epithemia sorex, Hantzchia amphioxys* with varieties, *Nitzschia frustulum* var. *perminuta,* and *Nitzschia Clausii.* In the main features, the growth forms are identical in type, but the floristic composition is different. Predominant are *Navicula Lagerheimii* Cleve and its three varieties. This diatom is known from moist rocks in Ecuador, South America, from tropical Africa, from mountain bogs of Java, and was recently reported from barks of trees in Calcutta, India. Common in Shanghai are *Hantszchia amphioxys, Melosira Roesana* var. *epidendron, Cymbella turgidula,* and *Rhopalodia gibba.* It was unusual to find *Rhopalodia Novae-Zealandiae* reported only from New Zealand. Two specimens were seen of this rare species. The following is the description of all diatoms recorded from

this small collection. The diagrams of the author are made by Apochromat 2 and Compens Ocular 4 of E. Leitz, Weitzlar.

MELOSIRA ROESEANA Rabh. var. EPIDENDRON Grunow. Plate 1, figs. 14 to 16.

Melosira Roeseana Rabh. var. *epidendron* Grunow, VAN HEURCK, Synopsis (1880–1881) pl. 89, figs. 17, 18; FR. HUSTEDT, Kieselalgen (1927) 268, figs. 112*c*, *d*.

Valve cylindrical, with distinct pseudosulkus. Discus rim denticulate. Sulkus and neck broad. Cell wall with fine puncta in longitudinal rows. Valve covered with radiating rows of beads, central area with three large granules. Valve breadth, 0.0085 to 0.0136 mm; height, 0.01 to 0.014. Striæ 16 to 18 in 0.01 mm. Common. Reported from mosses and rocks in mountainous districts.

MERIDION CIRCULARE Agardh var. CONSTRICTA (Ralfs) Van Heurck. Plate 1, fig. 21.

Meridion circulare Agardh var. *constricta* (Ralfs) Van Heurck, FR. HUSTEDT, Bacillar. (1930) 131, fig. 119.

Valve clavate, with subcapitate apex and attenuate ends. Length, 0.037 mm; breadth, 0.006. Costæ 3, striæ 20 in 0.01 mm. Infrequent. Common in running water.

SYNEDRA ULNA (Nitzsch) Ehr. Plate 2, fig. 5.

Synedra ulna (Nitzsch) Ehr., FR. HUSTEDT, Bacillar. (1930) 151, 152, figs. 158, 159.

Valve linear-lanceolate, with attenuate, subacute ends. Length, 0.102 mm; breadth, 0.0042. Striæ transverse, 10 in 0.01 mm. Infrequent. Common in fresh water.

SYNEDRA RUMPENS Kütz. var. MENEGHINIANA Grunow. Plate 2, fig. 6.

Synedra rumpens Kütz. var. *Meneghiniana* Grunow, FR. HUSTEDT, Bacillar. (1930) 156, fig. 178.

Valve linear-lanceolate, gradually tapering from the middle to subacute ends. Length, 0.0816 mm; breadth, 0.0025. Striæ robust, distinct, 12 in 0.01 mm. Infrequent.

COCCONEIS PLACENTULA (Ehr.). Plate 2, fig. 10.

Cocconeis placentula (Ehr.), FR. HUSTEDT, Bacillar. (1930) 189, fig. 260.

Valve elliptic, with broad-rounded ends. Length, 0.017 mm; breadth, 0.012. The upper valve with narrow axial area. Striæ radiate, punctate, in longitudinal lines, 12 in 0.01 mm. Infrequent.

FRUSTULIA RHOMBOIDES (Ehr.) de Toni var. SAXONICA (Rabh.) de Toni. Plate 1, fig. 19.

Frustulia rhomboides (Ehr.) de Toni var. *saxonica* (Rabh.) de Toni, FR. HUSTEDT, Bacillar. (1930) 221, fig. 325.

Valve elliptic-lanceolate, tapering from the middle to subacute ends. Length, 0.061 mm; breadth, 0.012. Not common.

Genus NAVICULA Bory

NAVICULÆ LINEOLATÆ CLEVE

NAVICULA IGNOTA Krasske. Plate 1, fig. 25.

Navicula ignota KRASSKE, Beiträge zur Kenntnis der Diatomeenflora der Alphen. Hedwigia 72 (1932) 116, pl. fig. 19.

Navicula Licenti SKVORTZOW in Diatoms recoltees par le Pere E. Licent au cours de ses voyages dans le Nord de la Chine (1935) 40, pl. 9, figs. 11, 29.

Valve linear-lanceolate, triundulate, with rostrate, obtuse, ends. Length, 0.0357 mm, breadth, 0.005. Striæ slightly radiate, 15 in 0.01 mm. Not common. Larger than the type. Reported from mosses, Europe.

NAVICULA CINCTA (Ehr.) Kütz. var. MINUTA var. nov. Plate 1, fig. 17.

Valvis minoribus quam species, lineari-lanceolatis, cum polis rotundatis. Valvis longis, 0.0136 mm; latis 0.0034. Striis 12 in 0.01 mm, radiantes. Habit. in truncus arboris muscosis, Shanghai, Legit I. Kovalchuk-Koval.

Valve linear-lanceolate, with attenuate, rounded, ends. Axial area narrow, central broader. Striæ radiate. Length, 0.0136 mm; breadth, 0.0034. Striæ radiate, 12 in 0.01 mm. Differs from the type in its smaller size. The type is reported from fresh and brackish water.

NAVICULÆ ENTOLEIÆ CLEVE

NAVICULA CONTENTA Grun. fo. BICEPS Arnott. Plate 1, figs. 1 and 2.

Navicula contenta Grun., FR. HUSTEDT, Bacillar. (1930) 277, fig. 458*c*.

Valve linear, constricted in the middle part. Ends broad, subcapitate. Length, 0.0059 to 0.0085 mm; breadth, 0.0025. Striæ indistinct. Abundant. Reported from mosses.

NAVICULÆ MESOLEIÆ CLEVE

NAVICULA LAGERHEIMII Cleve. Plate 1, figs. 8 and 9.

Navicula Lagerheimii CLEVE, Synopsis of the Naviculoid Diatoms (1894) 1, 131; FR. HUSTEDT, Bacillariales aus Zellpflanzen Ostafrikas, gesammelt auf der akademischen Studienfahrt 1910. Hedwigia 62 (1921) 153, pl. 1, figs. 13, 15; A. SCHMIDT, Atlas Diatom. (1930) pl. 370, figs. 19–21.

Valve rhomboid-lanceolate, dilated in the middle, slightly triundulate with truncate ends. Length, 0.017 to 0.02 mm; breadth, 0.0068. Median line straight with central pores and

terminal fissures curved in the same directions. Axial area very narrow; central area a broad, transverse rectangular fascia, reaching nearly to the margin, with an isolated punctum. Striæ 18 to 20 in 0.01 mm, radiate at the ends, coarsely punctate; puncta very fine. Not common. Reported on moist rocks from Ecuador, Pichincha, South America, from a mountain swamp in Java, and from tropical Africa.

NAVICULA LAGERHEIMII var. INTERMEDIA Hustedt. Plate 1, figs. 3, 4, and 32.

Navicula Lagerheimii Cleve var. *intermedia* Hustedt, A. SCHMIDT, Atlas Diatom. (1930) pl. 370, fig. 22.

Navicula pseudoseminulum Skvortzow and var. *curta* SKVORTZOW, Diatoms from Calcutta, India (1935) 183, pl. 1, figs. 18, 19.

Navicula pseudoseminulum SKVORTZOW, Diatoms recoltees par le Pere E. Licent dans le Nord de la Chine (1935) 40, pl. 9, fig. 27.

Differs from the type in its elliptic, not triundulate valves, with broad, obtuse ends. Length, 0.015 to 0.0204 mm; breadth, 0.0053 to 0.0068. Striæ radiate, 18 to 20 in 0.01 mm, with a distinct isolated punctum on one side of the valve. This variety is reported from mountain bogs in Java, from bark of trees in Calcutta, India, and from barks of trees in northern Manchuria.

NAVICULA LAGERHEIMII Cleve var. CAPITATA var. nov. Plate 1, fig. 7.

Differt a typo polis capitatis. Poro solitario distinctis. Valvis longis 0.015 mm; latis 0.0068. Striis 18 in 0.01 mm. Habit. in truncus arborum muscosis, Shanghai. Legit I. Kovalchuk-Koval.

Valve elliptic-ovate, with capitate ends. Isolated puncta distinct. Length, 0.015 mm; breadth, 0.0068. Striæ 18 in 0.01 mm. Differs from the type in its capitate ends. Infrequent.

NAVICULA LAGERHEIMII Cleve var. OVATA var. nov. Plate 1, figs. 5, 6, and 24.

Differt a var. intermedia valvis abbreviatis, ovatis, cum polis rotundatis. Valvis longis 0.0085 ad 0.01 mm; latis 0.005 ad 0.0068. Striis 18 ad 20 in 0.01. Habit. in truncus arborum muscosis, Shanghai. Legit I. Kovalchuk-Koval.

Valve ovate, slightly attenuate and rounded at the ends. Length, 0.0085 to 0.01 mm; breadth, 0.005 to 0.0068. Striæ 18 to 20 in 0.01 mm. Differs from var. *intermedia* in its shorter and more rounded ends. Not common.

PINNULARIA GIBBA Ehr. Plate 1, fig. 26.

Pinnularia gibba Ehr., FR. HUSTEDT, Bacillar. (1930) 327, fig. 600.

Valve linear, with almost parallel margins and subcapitate, slightly apiculate ends. Axial area narrow, central area a

broad fascia. Length, 0.068 mm; breadth, 0.012. **Striæ** radiate, 9 in 0.01 mm. Rare.

AMPHORA NORMANII Rabh.? Plate 1, fig. 18.

Amphora Normanii Rabh., VAN HEURCK, Synopsis (1880–1881) pl. 1, fig. 12; FR. HUSTEDT, Bacillar. (1930) 343–344, fig. 630.

Valve semielliptic, arcuate on dorsal and almost straight on ventral margins. Length, 0.012 mm; breadth, 0.0025. Striæ indistinct. Smaller than the type. An alpine species, common in mosses.

CYMBELLA PERPUSILLA A. Cleve. Plate 1, fig. 10.

Cymbella perpusilla A. CLEVE, On recent fresh-water diatoms from Lule Lappmark in Sweden (1895) 19, pl. 1, fig. 13.

Valve asymmetrical, lanceolate, with moderately arcuate dorsal, and almost straight ventral margins. Ends obtuse. Length, 0.0153 mm; breadth, 0.0042. Striæ slightly radiate, ventral and dorsal 18 to 20 in 0.01 mm. No isolated punctum. Infrequent. A mountain and northern species, reported from Europe.

CYMBELLA CISTULA (Hemp.) Grun. Plate 2, fig. 11.

Cymbella cistula (Hemp.) Grun., FR. HUSTEDT, Bacillar. (1930) 363, fig. 676*a*.

Valve asymmetrical, boat-shaped, with arcuate dorsal and centrally gibbous ventral margins. Ends attenuate, obtuse. Length, 0.061 to 0.01 mm; breadth, 0.017 to 20. Striæ robust, punctate, ventral 9, dorsal 6 in 0.01 mm. Infrequent.

CYMBELLA TURGIDULA Grun. Plate 1, figs. 27 and 31.

Cymbella turgidula Grun., FR. HUSTEDT, Bacillar. (1930) 362, fig. 670; A. SCHMIDT, Atlas Diatom. (1931) pl. 376, figs. 8 to 13.

Valve asymmetrical, elliptic-lanceolate with arcuate dorsal margin and centrally gibbous ventral margin. Ends subrostrate and obtuse. Length, 0.0408 mm; breadth, 0.011 to 0.0136. Striæ robust, punctate, radiate, ventral 8 to 9, dorsal 7 to 8 in 0.01 mm, with one or two distinct isolated puncta near the central nodule. Infrequent. Common in tropical regions.

GOMPHONEMA CONSTRICTUM Ehr. Plate 2, fig. 3.

Gomphonema constrictum Ehr., FR. HUSTEDT, Bacillar. (1930) 377, fig. 714; A. SCHMIDT, Atlas Diatom. (1904) pl. 247, figs. 3–11.

Valve clavate, with broad-capitate apex and narrow basis. Length, 0.037 mm; breadth, 0.01. Striæ 12 in 0.01 mm. Rare.

GOMPHONEMA GRACILE Ehr. Plate 1, fig. 20.

Gomphonema gracile Ehr., FR. HUSTEDT, Bacillar. (1930) 376, fig. 702.

Valve lanceolate-naviculiform, slightly clavate. One end broader than the other. Length, 0.0408 mm; breadth, 0.0085. Isolated punctum distinct. Infrequent.

RHOPALODIA GIBBA (Ehr.) O. Müll. Plate 1, fig. 30; Plate 2, figs. 1, 2, and 12.

Rhopalodia gibba (Ehr.) O. Müll., A. SCHMIDT, Atlas Diatom. (1905) pl. 253, figs. 1–13.

Valve linear, arcuate in the middle part of the dorsal margin and slightly reflexed and attenuate at the ends. Length, 0.056 to 0.101 mm; breadth, 0.009 to 0.01. Costæ 7, striæ 14 to 18 in 0.01 mm. Common.

RHOPALODIA NOVAE ZEALANDIAE Hustedt. Plate 1, fig. 29.

Rhopalodia Novae Zealandiae Hustedt, A. SCHMIDT, Atlas Diatom. (1913) pl. 294, fig. 40.

Valve semilanceolate, gradually arcuate at the dorsal margin and interrupted in the middle part. Straight on ventral margin. Length, 0.095 mm; breadth, 0.01. Striæ 15 in 0.01 mm. No robust costæ. Rare. Reported from New Zealand.

EPITHEMIA ZEBRA (Ehr.) Kütz. Plate 2, fig. 9.

Epithemia zebra (Ehr.) Kütz., FR. HUSTEDT, Bacillar. (1930) 384, 385, fig. 729.

Valve semielliptic, arcuate at the dorsal margin and almost straight at the ventral. Length, 0.0374 mm; breadth, 0.01. Costæ 3, striæ 9 to 10 in 0.01 mm. Not common.

EPITHEMIA ZEBRA (Ehr.) Kütz. var. **PORCELLUS** (Kütz.) Grunow. Plate 2, fig. 8.

Epithemia zebra (Ehr.) Kütz. var. *porcellus* (Kütz.) Grunow, FR. HUSTEDT, Bacillar. (1930) 385, fig. 731.

Valve semielliptic, with capitate ends. Length, 0.0476 mm; breadth, 0.0085. Costæ 4, striæ 9 to 10 in 0.01 mm. Common.

EPITHEMIA SOREX Kütz. Plate 2, fig. 4.

Epithemia sorex Kütz., FR. HUSTEDT, Bacillar. (1930) 388, fig. 736, A. SCHMIDT, Atlas Diatom. (1904) pl. 252, figs. 22–28.

Valve lunate, with arcuate dorsal and convex ventral margins. Ends capitate. Length, 0.0374 mm; breadth, 0.01. Costæ 7 in 0.01 mm. Infrequent.

HANTZSCHIA AMPHIOXYS (Ehr.) Grunow. Plate 1, figs. 11, 12, and 28.

Hantzschia amphioxys (Ehr.) Grunow, A. SCHMIDT, Atlas Diatom. (1921) pl. 329, figs. 15–20.

Valve linear, asymmetrical with slightly arcuate dorsal and convex ventral margins. End subrostrate and obtuse. Length,

0.0289 to 0.034 mm; breadth, 0.0051 to 0.0058. Costæ 5 to 10, striæ 20 to 23 in 0.01 mm. Common. A diatom common in mosses and on moist rocks.

HANTZSCHIA AMPHIOXYS (Ehr.) Grun. var. XEROPHILA Grunow. Plate 1, fig. 13.

Hantzschia amphioxys (Ehr.) Grun. var. *xerophila* GRUNOW, A. Diatomeen von Franz Josefs Land (1884) 99.

Valve minute, linear, with subrostrate ends. Length, 0.022 mm; breadth, 0.0034. Costæ 8, striæ about 30 to 35 in 0.01 mm. Infrequent. Differs from the type in its coarser striæ.

HANTZSCHIA AMPHIOXYS (Ehr.) Grun. var. RUPESTRIS Grunow. Plate 2, fig. 7.

Hantzschia amphioxys (Ehr.) Grun. var. *rupestris* Grunow, A. SCHMIDT, Atlas Diatom. (1922) pl. 345, fig. 14.

Differs from the type in the more elongate ends. Length, 0.057 mm; breadth, 0.0068. Costæ 7, striæ 18 in 0.01 mm. Infrequent.

NITZSCHIA FRUSTULUM (Kütz.) Grun. var. PERMINUTA Grunow. Plate 1, fig. 23.

Nitzschia frustulum (Kütz.) Grun. var. *perminuta* Grunow, VAN HEURCK, Synopsis (1880–1881) pl. 99, fig. 7.

Valve lanceolate, with subacute ends. Length, 0.055 mm; breadth, 0.0022. Costæ 14 in 0.01 mm. Striæ very fine, indistinct. Reported from the bark of trees in Calcutta, India.

NITZSCHIA CLAUSII Hantzsch. Plate 1, fig. 22.

Nitzschia Clausii Hantzsch, A. SCHMIDT, Atlas Diatom. (1921) pl. 336, figs. 7–11.

Valve linear, with sigmoid, attenuate, acute, ends. Length, 0.0357 mm; breadth, 0.0025. Costæ 8 in 0.01 mm. Striæ indistinct. Infrequent. Reported from fresh and brackish water.

BIBLIOGRAPHY

CLEVE, A. On recent freshwater diatoms from Lule Lappmark in Sweden. Bihang Till K. Svenska Vet. Akad. Handlingar 21 No. 2 (1895) pl. 3.

GRUNOW, A. Die Diatomeen von Franz Josefs Land. Wien (1884).

HUSTEDT, FR. Bacillariales aus Zellpflanzen Ostafrikas gesammelt auf der akademischen Studienfahrt 1910. Hedwigia 62 (1921).

HUSTEDT, FR. Bacillariophyta. Jena (1930).

HUSTEDT, FR. Die Kieselalgen in Dr. L. Rabenhorsts Kryptogamen Flora, Leipzig (1927).

KRASSKE, G. Beiträge zur Kenntnis der Diatomeenflora der Alpen. Hedwigia 72 (1932).

SCHMIDT, A. Atlas Diatomaceenkunde. Leipzig (1875–1931).

SKVORTZOW, B. W. Diatomees recoltees par le Pere E. Licent au cours de ses voyages dans le Nord de la Chine. Tientsin (1935).

SKVORTZOW, B. W. Diatoms from Calcutta, India. Philip. Journ. Sci. 58 (1935) 179.

VAN HEURCK, H. Synopsis des Diatomees Belgique. Anvers (1880–1885).

ILLUSTRATIONS

PLATE 1

FIGS. 1 and 2. *Navicula contenta* fo. *biceps* Arnott.
3 and 4. *Navicula Lagerheimii* Cleve var. *intermedia* Hust.
5 and 6. *Navicula Lagerheimii* Cleve var. *ovata* var. nov.
FIG. 7. *Navicula Lagerheimii* Cleve var. *capitata* var. nov.
FIGS. 8 and 9. *Navicula Lagerheimii* Cleve.
FIG. 10. *Cymbella perpusilla* A. Cleve.
FIGS. 11 and 12. *Hantzschia amphioxys* (Ehr.) Grun.
FIG. 13. *Hantzschia amphioxys* (Ehr.) Grun. var. *xerophila* Grun.
FIGS. 14 to 16. *Melosira Roeseana* Rabh. var. *epidendron* Grun.
FIG. 17. *Navicula cincta* (Ehr.) Kütz. var. *minuta* var. nov.
18. *Amphora Normanii* Rabh.?
19. *Frustulia rhomboides* (Ehr.) de Toni var. *saxonica* (Rabh.) de Toni.
20. *Gomphonema gracile* Ehr.
21. *Meridion circulare* Agardh var. *constricta* (Ralfs) Van Heurck.
22. *Nitzschia Clausii* Hantz.
23. *Nitzschia frustulum* (Kütz.) Grun. var. *perminuta* Grun.
24. *Navicula Lagerheimii* Cleve var. *ovata* var. nov.
25. *Navicula ignota* Krasske.
26. *Pinnularia gibba* Ehr.
27. *Cymbella turgidula* Grun.
28. *Hantzschia amphioxys* (Ehr.) Grun.
29. *Rhopalodia Novae Zealandiae* Hust.
30. *Rhopalodia gibba* (Ehr.) O. Müll.
31. *Cymbella turgidula* Grun.
32. *Navicula Lagerheimii* Cleve var. *intermedia* Hust.

PLATE 2

FIGS. 1 and 2. *Rhopalodia gibba* (Ehr.) O. Müll.
FIG. 3. *Gomphonema constrictum* Ehr.
4. *Epithemia sorex* Kütz.
5. *Synedra ulna* (Nitzsch) Ehr.
6. *Synedra rumpens* Kütz. var. *Meneghiniana* Grun.
7. *Hantzschia amphioxys* (Ehr.) Grun. var. *rupestris* Grun.
8. *Epithemia zebra* (Ehr.) Kütz. var. *porcellus* (Kütz.) Grun.
9. *Epithemia zebra* (Ehr.) Kütz.
10. *Cocconeis placentula* (Ehr.)
11. *Cymbella cistula* (Hemp.) Grun.
12. *Rhopalodia gibba* (Ehr.) O. Müll.

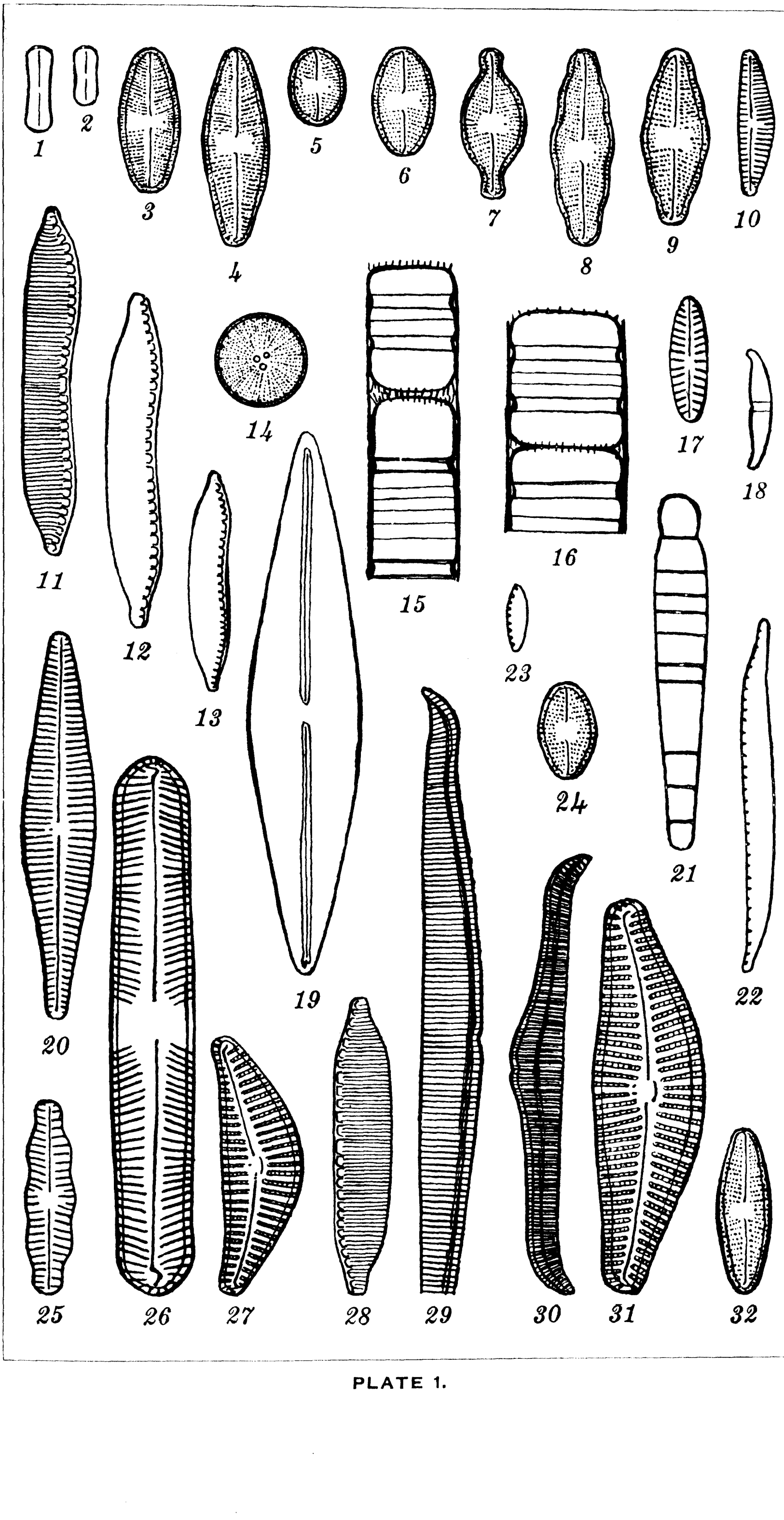

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PLATE 1.

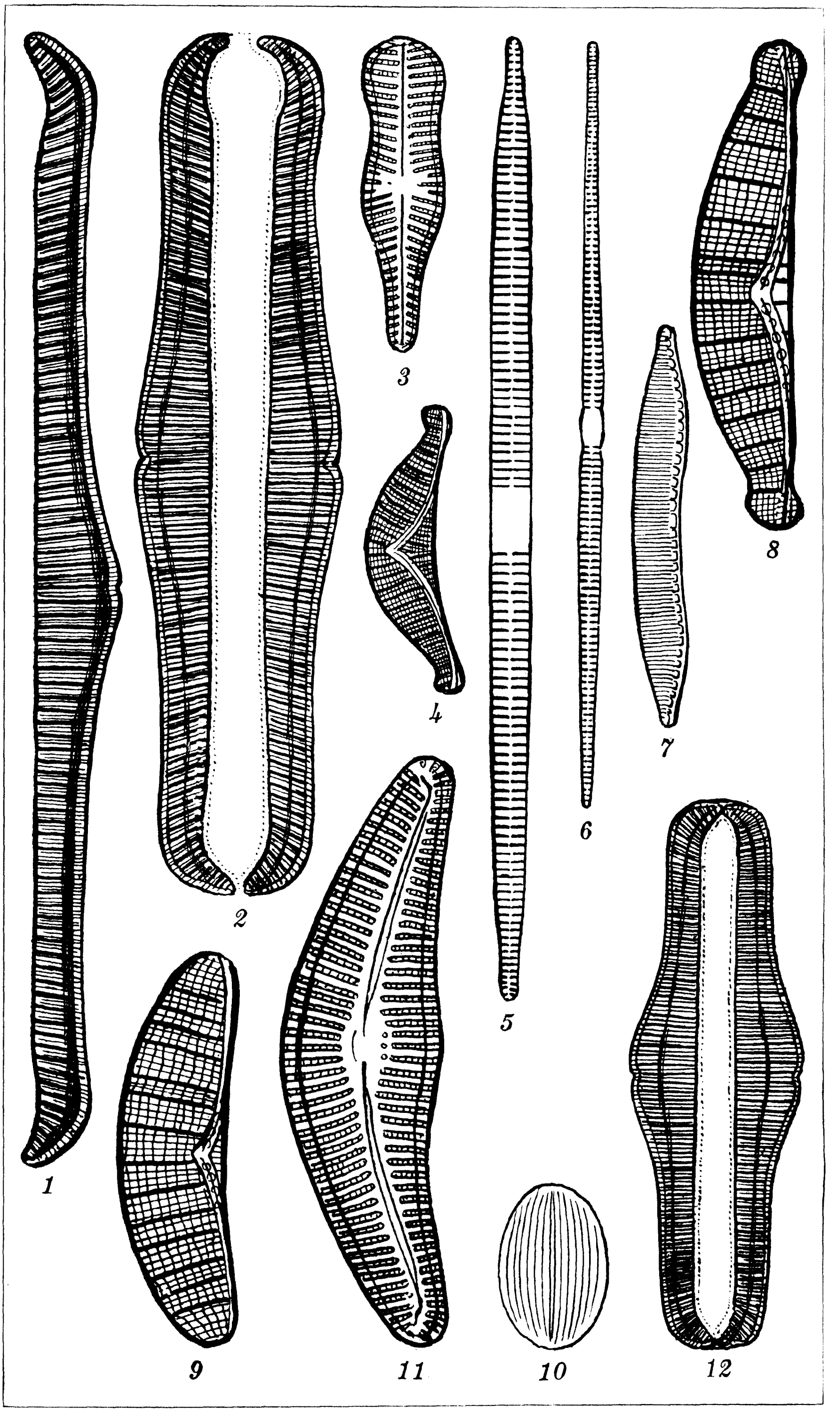

PLATE 2.

BOOKS

Acknowledgment of all books received by the Philippine Journal of Science will be made in this column, from which a selection will be made for review.

RECEIVED

Academy of natural science of Philadelphia. Discovery: science at work, by the Managing director. The Academy, 1936. 20 pp. Gratis.

American medicine; expert testimony out of court. 2 vols. New York, The American foundation, c1937. 1435 pp. Price, $3.50.

AUSTEN, E. E. Bombyliidæ of Palestine. With seventy-two text figures, a frontispiece, and a map, by A. J. Engel Terzi, and three photographic plates. London, The Trustees of the British Museum, 1937. 188 pp. Price, 15s.

BAUER, W. W. Health questions answered. New York, Bobbs-Merrill co., c1937. 368 pp. Price, $2.

DALZELL, J. RALPH, and JAMES MCKINNEY. Air conditioning—insulation. Treats of the principles and applications of insulation as used to retard heat losses and gains, and to guard against fire, sound, vibration, condensation, and termites in buildings. Chicago, American Technical society, 1937. 301 pp., illus. Price, $2.50.

EMERSON, A E., and ELEANOR FISH. Termite city. With a foreword by William Beebe. San Francisco, Rand McNally and co., c1937. 127 pp., illus. Price, $1.50.

GARIBALDI, AMERICO. Mecanismo probable de la cancerizacion (Ensayo patogénico). Editado por la Facultad de Ciencias Medicas, Universidad Mayor de San Marcos, Lima (Peru). 1936. 2 Vols.

GREGG, A. L. Tropical nursing. A handbook for nurses and others going abroad. With a foreword by the Hon. Sir Arthur Stanley. London, Cassell and co., ltd., 1929. 199 pp. Price, 6s.

A Guide to the mineral gallery, British Museum (Natural History). 14th ed. London, The Trustees of the British Museum, 1937. 60 pp. Price, 6d.

Harvard journal of Asiatic studies. Edited by Serge Elisséeff. Published by the Harvard-Yenching Institute. A quarterly journal devoted to scholarly articles on Eastern or Central Asia, or to India. Subscription price, $5.

Harvard school of public health. The environment and its effect upon man; symposium held at Harvard School of public health, August 24–29, 1936, as part of Harvard University tercentenary celebration, 1636–1936. Boston, Harvard school of public health, 1937. 297 pp., tables, illus.

KENNEDY, WILLIAM F. The objective rate plan; for reducing the price of residential electricity. New York, Columbia university press, 1937. 83 pp., tables, charts. Price, $1.25.

KLAR, M. Fabrikation von absoluten alkohol zweks verwendung als zusatzmittel zu motor-tirebstoffen. Halle (Saale) Germany, Wilhelm Knapp, 1936. 84 pp., illus. Price, Rm4.20.

LARSON, T. H. Philosophy of corrective medicine. Los Angeles, Chicago College of endocrinology, c1935. 20 pp.

League of Nations. International labour office. Geneva. Workers' nutrition and social policy. London, P. S. King & son, ltd., 1936. 249 pp., tables. Price, $1.50.

Medicolegal cases. Abstracts of court decisions of medico-legal interest, 1931–1935. Compiled by the Bureau of Legal medicine and legislation, American medical association, Chicago, 1936. 888 pp. Price, $5.50.

MORRISON, L. H. High-speed diesel engines. A practical text on high-speed diesels, including instruction on fuel-injection and combustion systems, frames and cylinders, running gear, and construction details of the different models of the diesel engines and their applications to industry and transportation. Chicago, American technical society, 1937. 243 pp., illus. Price, $2.50.

NORMAN, J. R. Illustrated guide to the fish gallery, British Museum (Natural History). London, The trustees of the British Museum, 1937. 175 pp. Price, 1s 6d.

Osaka Imperial university. Collected papers from the Faculty of science, Osaka Imperial university. Series B. Physics, vol. 4, 1936. Osaka, The University, 1937. 33 papers.

OTTER, G. W. Rock-destroying organisms in relation to reefs. Great Barrier Reef Expedition, 1928–29, Scientific Reports, vol. 1, No. 12, p. 323–352, plates, illus. London, British Museum (Natural History), 1937. Price, 5s.

SCHOUTE, D. Occidental therapeutics in the Netherlands East Indies during three centuries of Netherlands settlement (1600–1900). Publications of the Netherlands Indies public health service, Batavia, 1937. 214 pp.

SWAN, J. P. The vaccination problem. London, The C. W. Daniel co., ltd., 1936. 320 pp. Price, 5s.

SWEETMAN, H. L. The biological control of insects. With a chapter on weed control. With a foreword by L. O. Howard. Ithaca, N. Y., Comtock publishing co., inc., 1936. 461 pp., illus. Price, $3.75.

TROMP, L. A. Machinery and equipment of the cane sugar factory; a textbook on machinery for the cane sugar industry. London, Norman Rodger, 1936. 644 pp., illus. Price, 31s 6d.

WARD, H. B., and others, *ed.* Some fundamental aspects of the cancer problem; symposium sponsored by the section on medical sciences of the American Association for the Advancement of Science, Atlantic City, New Jersey, Dec. 29, 1936–Jan. 1, 1937. New York, The Science Press, 1937. 248 pp., illus., charts., tables. Price, $2.

WILLIAMS, C. B. Butterfly migrations in the tropics. London, British Museum (Natural History), 1937.

WINSTON, S. E. Thermodynamics. A practical text covering the fundamentals of thermodynamics that are basic to the engineering field. Chicago, American technical society, 1937. 178 pp., illus. Price, $1.50.

WOOD, R. C. A note-book of tropical agriculture. Trinidad, The Imperial college of tropical agriculture, 1937. 147 pp.

REVIEWS

Air Conditioning; Fundamental Principles, Practical Installations and Ozone Facts. By E. W. Riesbeck. Chicago, Goodheart Willcox Company, Inc., 1934. 352 pp., illus., diagrams, charts. Price, $3.50.

This book is written in nontechnical language, so that anyone wishing to familiarize himself with air conditioning and related subjects, such as refrigeration, cold storage, plant operation, the use of ozone, and the sterilization of water, may gain a thorough understanding of these important subjects. The author has had many years of practical experience in heating, ventilating, air conditioning, and power-plant operation. The book is well illustrated with charts, diagrams, and photographic reproductions of air-conditioning apparatus and their auxiliaries.

This book does not only profit designers, manufacturers and owners of air-conditioning apparatus, but it is also important for students and the general public to gain further knowledge about the value and benefit of air conditioning.—B. R. D.

A Catalogue of the African Hesperiidæ; Indicating the Classification and Nomenclature Adopted in the British Museum. By Brigadier W. H. Evans. London, Printed by Order of the Trustees of the British Museum, 1937. 212 pp., 30 Plates. With a Preface by N. D. Riley, Keeper of Entomology, British Museum (Natural History). Price, £1.

This catalogue is a notable contribution to systematic entomology and should be of value especially to workers on skippers (Hesperiidæ). As Captain Riley states in the preface, the title of the volume and its size are but a very poor indication of the labor involved in the compilation of the book and the extent of the additions made by the author to the knowledge of the African skippers. Indeed, the book is not a mere catalogue, as the author has brought the classification of the members of the family up to date and has correlated certain Æthiopian and Oriental genera.

The author's classification of the members of the Hesperiidæ is the most advanced so far. He has divided the family into nine groups with seventy genera, four hundred twenty-two species, and two hundred sixty-six subspecies or forms, of which sixteen genera, sixty-seven species, and seventy-eight subspecies or forms are new.

Because of the purely nontechnical words employed in the various descriptions, the book is very useful to lay people who may wish to collect insects merely for their beauty and rarity, and as a reference book for beginning students in systematic entomology.—S. R. C.

Diseases of Vegetable Crops. By J. C. Walker. Ann Arbor, Michigan, Edwards Brothers, Inc., 1936. 65 pp. Price, $1.60.

This book gives in outline the important facts concerning the major diseases of vegetable crops. Brief notes are given on the culture and marketing of each crop plant, and the diseases are taken up according to host groups. The major diseases are treated under the following heads: Hosts, history, occurrence, economic importance, symptoms, causal organism, life history of causal organism, pathological histology, environmental relations, varietal resistance, and control. Many minor diseases are also listed. To each disease are appended a number of key references. The book has an index of diseases arranged alphabetically under hosts.

This book is a handy reference for vegetable gardeners and for students of plant pathology. The text is a photo-lithoprint reproduction of the author's manuscript and, being reproduced on one side of the page only, leaves a useful blank side for notes and other remarks on local conditions.—J. M. M.

Electrolytic Oxidation and Reduction: Inorganic and Organic. By S. Glasstone and A. Hickling. New York, D. Van Nostrand Company, Inc., 1936. 420 pp. Price, $9.

This book gives a good survey of the field indicated by its title. It deals with reactions involving inorganic as well as organic compounds, giving brief but comprehensive and clear discussions of the oxidation and reduction processes carried out by electrolytic methods, as well as of the underlying principles of the reactions described. Frequent reference is made to the recent as well as to the older investigations on the subject.

At the end of each of the eleven chapters is a good bibliography of the subject treated. Such lists of references are not easily available elsewhere, and should make the volume helpful to lecturers and researchers in the field of electrolytic oxidation and reduction.—F. L. R.

Ford V8 Cars and Trucks; Construction—Operation—Repair; a Most Complete and Practical Manual Explaining the Construction of all Parts of Late Model Ford Automobiles with Instructions for Driving, Servic-

ing and Repairing; Written in Simple Language; a Universal Book of Reference. By Victor W. Page. New York, Norman W. Henley Publishing Co., 1937. 360 pp., charts, diagrams, photo. Price, $2.50.

This volume is a complete treatise on all Ford V8 cars from the earliest 1932 models to the latest 1937 cars. The author, who has been writing the Ford Manual as a yearly feature since 1912, is an expert on Ford cars, who owned and operated numerous models, starting from Model T. The book is thoroughly illustrated by many specially made diagrams and distinctive original photographs of actual parts furnished by the factory service department.

As stated by the author, there is no royal road to knowledge. Experience, supplemented by the study of the instructions contained in this treatise, is the best teacher. The book is divided into twenty-one chapters of authoritative and comprehensive data about performance, operation, upkeep, and practical application.

This book is a valuable reference for owners, operators, service men, dealers, and mechanics of the Ford V8, for it meets every question with regard to Ford cars.—B. R. D.

A Handbook of Tropical Therapeutics. By R. N. Chopra. Calcutta, Art Press, 1936. 1748 pp. Price, ₱27.50.

This encyclopædic work on tropical diseases is written by a man who is highly qualified to write a book on such a subject. For fifteen years he has been closely associated with postgraduate students at the Calcutta School of Tropical Medicine of which he is the Director. As superintendent of the Carmichael Hospital for Tropical Diseases he has also conducted pharmacological investigations in his laboratories in the hospital. In this book the author attempts "to review the whole subject of therapeutics with due regard to the climatic conditions met with in the tropics generally and in India particularly."

The book is divided into six parts. Part I deals with general considerations of therapeutics, and includes such intricate subjects as the action of drugs, conditions modifying drug action, modes of administration and details of technique, chemotherapy, physiotherapy, diet and dietetics in the Tropics, the treatment of pain and insomnia, and the use of tonics. Part II is a complete exposition of remedies used against helminthic diseases, those acting on cestodes and nematodes, as well as miscellaneous anthelmintics and their action on somatic parasites. Part III

deals with remedies used against protozoan diseases, amœbiasis, leishmaniasis, trypanosomiasis, malaria, and spirochætosis. Part IV discusses the treatment of bacterial and virus diseases, which are of special interest in tropical climates. A large amount of space has been allotted to the general discussion of vaccines, sera, and bacteriophages in therapeutics. Part V deals with the treatment of miscellaneous diseases met with in the Tropics. The nutritional disorders, such as beriberi, epidemic dropsy, and pellagra, and metabolic disorders, including diabetes mellitus and obesity, are dealt with. Part VI deals with the treatment of skin diseases, and is followed by a dictionary of diagnosis and treatment of the conditions met with in the Tropics, which cannot be strictly grouped under the heading of tropical diseases. The appendices contain abstracts from journals, bringing certain sections up to date (end of 1935); there are also posological tables of drugs and preparations, notes regarding important nonofficial remedies, physiological constants, tables of bacteria, metazoa and protozoa, and a large amount of other information required almost every day by the medical practitioner.

This book is a very valuable addition to the few available works on tropical medicine. There are 1,748 pages packed with useful information especially valuable to medical practitioners in the Philippines. The book is highly recommended as a useful reference book for physicians.—M. B.

Heart Disease and Tuberculosis; Efforts Including Methods of Diaphragmatic and Costal Respiration to Lessen their Prevalence. By S. Adolphus Knopf. New York, Livingston Press, 1936. 108 pp., illus. Price, $1.25.

The bold introductory remark that "heart disease is now king of Death," sounds interesting and invites the reader to go on further in the vast field of cardiac incidence and mortality in the United States, where the author has distinguished himself as an eminent phthisiologist. His assertion is ably supported by statistics and figures from insurance companies. On this account he pleads for a more extensive program of treatment and prevention for heart disease similar to what is being done for tuberculosis. After giving short remarks on the etiology, modern therapy, and occupational incidence of heart diseases, particularly those of hypertensive and arteriosclerotic types, he dwels more comprehensively on diaphragmatic respiration and its benefit to circulatory diseases. The value of this new therapeutic adjunct, which no ordinary practitioner may ably estimate,

is shown by the many favorable remarks of prominent cardiologists.

Of all the interesting and instructive information given on tuberculosis, the use of the recently developed Power's X-ray camera, and ingenious instrument for taking rapid and economical X-ray pictures, is most striking from the point of view of public health. This apparatus would give invaluable service in the mass examination of school children and employees.

This little book is full of information, ably illustrated and indexed, and backed up by a wealth of experience in the field of cardiology and tuberculosis.—I. F.

House Wiring; a Treatise describing and illustrating up-to-date methods of installing electric light wiring, bell and telephone wiring, and burglar alarm wiring. By Thomas W. Poppe and Harold P. Strand. 8th ed. revised and enlarged. New York, Norman W. Henley Publishing Co., 1937. 256 pp., illus., diagrams. Price, $1.

This book is familiar to engineers and master electricians. The present edition is more fully illustrated and has been brought up to date by changes to conform with the latest rulings of the United States National Board of Fire Underwriters and the newest trade practices.

The book is written in simple language and so well illustrated that it is understandable even to those who are not technically trained. It is therefore a great help to apprentices, helpers, and electricians for the many labor- and time-saving operations and diagrams described and illustrated. The book consists of sixteen chapters full of useful and practical information on all problems of wiring.—F. D. M.

Malaria in Europe; an Ecological Study. By L. W. Hackett. London, Oxford University Press, 1937. 336 pp., illus., diagrams. Price, 10s 6d.

This admirable brief narration of malarious conditions in Europe contains abridged and correlated discussions on the malaria situation in different countries, such as Italy, Spain, Holland, the Balkans, and others. In the course of these discussions the malaria situation in countries outside of Europe, such as Panama, the United States, the Philippines, the Netherlands Indies, Malaya, India, and others, have also been touched upon. In a way, it is an exposition of newer findings, of theories and counter theories, of hypotheses and counterhypotheses, on malaria in Europe and abroad. For ten years, the author has done extensive work in the investigation and control of malaria in Europe under the Rockefeller Foundation.

The malaria situation of Europe became a puzzle when it was noted that there were places where the supposed anopheles vector of the diseases (*Anopheles maculipennis*) was abundant, and yet there was no malaria, and vice versa. The distribution of malaria in Europe thus revealed interesting fundamental facts.

The immunity or resistance of the human body against the malaria parasites is very well discussed. There are also chapters on the theory and practice in the treatment of malaria and the conditions of the temperate-climate malaria. Two chapters of particular interest to malariologists are those on the strategy of malaria control and on the various fundamental lines of attack upon the disease.

Fundamental measures in the control of malaria have been discussed under the following headings: (*a*) Suppression of gametocytes in human carriers; (*b*) protection of human beings from mosquitoes; (*c*) destruction of larvæ in the water; (*e*) permanent elimination of breeding places; (*d*) natural methods of control.—A. E.

Petroleum Development and Technology, 1937. Transactions of the American Institute of Mining and Metallurgical Engineers, Vol. 123, Petroleum Division. New York, The Institute, 1937. 689 pp. Price, $5.

This book is made up of a collection of selected papers delivered at the meetings of the Petroleum Division. The papers are grouped under seven chapter headings as follows: Production Engineering, Production Engineering Research, Stabilization, Petroleum Economics, Production, Petroleum Engineering Education, and Refining.

The Committee has included many papers on the engineering phases of petroleum technology. These papers deal with the latest development in production engineering, research, and refining. Considerable data is given concerning individual fields, producing horizons, well depths, output, and the like. Two chapters deal with the increasingly interesting and significant subjects of politics and business in their relations to the petroleum industry. The improvement of the training of future petroleum engineers is also discussed with emphasis on combined class and field work.

This book is composed of highly involved and technical papers that are related only in a general way. Although it gives a good idea of the recent developments in petroleum technology, it has small value for anyone wanting a general picture of that subject. However, the student or engineer desiring recent information on

a given phase of petroleum technology should find this a useful and interesting text.—W. B. M.

A Treatise on Materia Medica and Therapeutics, including **Pharmacy, Dispensing, Pharmacology and Administration of Drugs. By the Late** Rakhaldas Ghosh. 14th ed. by Birendra Nath Ghosh. Calcutta, Hilton & Co., 1936. xvi + 724 pp. Price, ₱6.50.

This enlarged and revised volume contains additions made by the author of the present edition to take care of the recent changes in the British Pharmaceutical Codex. It is now largely, a volume on pharmacology as applied to therapeutics. An extensive revision of some drugs was made, especially iron, general anæsthetics, opium, barbiturates, digitalis, anterior pituitary, ergot, quinine, and the vitamins. A discussion on the following drugs is included in the volume for the first time: thalium, myocrisin, eukodal, dilaudide, dicodide, evipan, sodium evipan, soneryl sodium, bulbocapnine, harmine, percaine, gavano, coramine, carditone, manganese butyrate, synthalin, neptal, carbasone, vioform, antivenom serum, and pertussis vaccine.

Those who are not acquainted with the work will find it a very useful source of information on the pharmacology and therapeutics of drugs and preparations, particularly those in the official British Pharmacopœia.

Part VI, which deals with Indian indigenous drugs, is of interest to workers on tropical medicinal plants, because it contains important data on a number of such drugs. Some of the drugs discussed in this part of the work, which are similar to those obtained from medicinal plants growing in the Philippines are: Bael fruit, dita bark, volatile oil from betel leaves, and dried bark of the stem of *Melia azadirachta.*—P. V.

Vitamins and Other Dietary Essentials. By W. R. Aykroyd. 2d ed. London, William Heinemann (Medical Books) Ltd., 1936. 226 pp. Price, 7s 6d.

This second edition of this most interesting book on the science of dietetics discusses remarkable and revolutionary changes in our fundamental ideas about medicine and public health. It is a valuable and instructive book, giving a comprehensive discussion of the historical development of the modern science of nutrition, deficiency diseases, vitamins, and other dietary essentials. The practical application of our present-day knowledge of the dietary properties of foodstuffs, especially on perfect diet and its close relation towards good physique and better health, is thoroughly covered.—A. J. H.

American Medicine; Expert Testimony Out of Court. The American Foundation, New York. c1937. 2 vols. 1435 pp. Price, $3.50 set.

The degree to which a government may serve its citizens, and, on the other hand, how citizens may best serve their government, is being studied by the American Foundation's Committee in Government, which is conducting research along these lines in ten fields.

American Medicine; Expert Testimony Out of Court contains the first fruits of this research. The present two volumes consist of excerpts from some 5,000 letters, written by 2,200 medical men, including deans of medical schools, professors of medicine, general practitioners, and specialists. The views of these men on medical care as a matter of human right, and on the question as to how the achievements of medical science can best be distributed, are analysed, classified, and correlated.

Among the outstanding ideas in the report are:

1. The solution of the problem of the indigent sick is the development of the highest type of doctor who is competent and willing to supply medical care on a broad social base.

2. Medical schools are performing a terrific task with increasing effectiveness, yet at present the quality of practice by the average physician is not good enough. Much still needs to be done to give better training to doctors. Once trained, moreover, they must keep in training.

3. Medical care is not a commodity. It is a changing fluid thing, not adaptable to the blue prints of social engineering.

4. Postgraduate training in medicine is necessary and should be subsidized by the State.

5. A license to practice medicine should not be good for life, unless the holder keeps abreast of the more important developments in medical science. The State should force upon even the reluctant or inert portions of the profession a reasonable degree of performance in the matter of intellectual activity and of keeping pace with times.

6. Free, flexible, and supported research is a primary practical factor in adequate medical care.

7. Even if adequate medical care were available now to all, a large part of the population would still choose quacks, cults, and patent medicines. In the United States there are each year some 40,000 cases of smallpox; one sees, too, and in spite of considerable popular education, a large dependence upon patent medicine, magic, and healers of various kinds; and it cannot be

said that all such dependence is based upon slender financial resources. Medical education and general education of a country must be integrated.

8. The enormous expense of modern diagnostic equipment should be borne by the state to improve medical care for patients in the lower income brackets.

The first division of the report contains a searching analysis of medicine itself, a discussion of possible improvements in medical practice, and a definition of objectives in medical education. The second division analyzes all the solutions of the problems that have been brought forward—health insurance in the various forms, state medicine, and others. Out of this presentation comes the clear indication that medical care of the sick in a government, as a living partnership, is possible only by giving medicine a new social purpose and direction through intelligent planning.

The report is a rich source of stimulating experience. It does not think for the reader, but it makes him think. No one who reads it can fail to learn a better medicine than the one he knew yesterday or before yesterday. The work has no index, but the contents are outlined in detail at the beginning of the book. The volumes are sold below cost so as to afford every medical man an opportunity to own a set.—D. d. l. P.

Appendicitis, When and How to Operate; a Guide for the General Practitioner. By W. J. Stewart McKay. Sydney, Australia, Angus & Robertson, Ltd., 1936. 260 pp., illus. Price, 6s.

This book is intended as a guide for the general practitioner in the country. In a very wordy style the author points out what a country practitioner should do before an operation, describing every step in a simple operation, and discussing the difficult cases that should not be operated. He believes that "cold is the chief exciting cause of appendicitis," and is most common among those suffering from enlarged tonsils and adenoids. Inspite of its wordiness, the book is valuable to general practitioners and surgeons of limited experience.—C. D. F.

Coffee; the Epic of a Commodity. By Heinrich Eduard Jacob. Translated by Eden and Cedar Paul. New York, Viking Press, 1935. 296 pp., illus. Price, $3.50.

Here is a book that is as stimulating as a drink of good coffee on a dull afternoon. It contains a fast-moving story, depicted against a rich romantic setting, of coffee and its addicts and

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more and more numerous converts. Coffee is portrayed as a hero whose struggles for supremacy over such formidable rivals as wine, beer, and other liquor during the last three centuries has influenced the trend of human culture and human thought,—of civilization itself. Like that of any other conqueror, the popularity of coffee has resulted in unprecedented heights of overproduction that has threatened its economic stability. But man's genius has time and again saved the commodity from economic collapse. There have been times when very drastic measures, such as wholesale destruction of plantations and crops, had to be taken to maintain the balance between production and consumption and to prevent prices from sinking to ruinous depths. To students of economics who seek to interpret the operation of economic laws in maintaining the trade value of world's commodities, this book carries a powerful message. Likewise, it has a peculiar literary appeal, for its author, who devoted five years to the study of coffee, is without doubt possessed of that rare gift of humanizing what in the hands of less accomplished authors would be a very drab subject to write about. The book contains much valuable information hitherto not of general public knowledge. It is the most complete treatise on the world's most popular beverage, the virtues of which are still being debated wherever it is drunk. The book itself is its best recommendation.—C. V. C.

College Men: Their Making and Unmaking. By Dom Proface. With a Foreword by Dean Theodore A. Distler. New York, P. J. Kenedy and sons, c1935. 314 pp. Price, $2.15.

The book is a vivid portrayal of college life in all its aspects. It touches on society, ethics, religion, sex, love, health, ideals, and principles of character—the big items in life students are heir to. It is interestingly human with its bits of pathos and sparks of humor, the material having been excerpted actually from intimate interviews with college men. This book is highly commendable, not only for boys in college but also for parents and educators whose natural interest in them is paramount.
—J. M.

Food Studies. By Lulu W. Gillum. Kansas City, Mo., Gillum Book Co., c1935. 624 pp., illus. Price, $2.

This is a very interesting and practical book written for girls in high school on food. The author presents the subject on the unit method, with an interesting introduction on health, the main objective of the ten-unit lessons. The text is provided with

teaching aids, such as illustrations, questions, exercises, tests, tables, and references.

The average girl who has not oriented herself in her home kitchen or who has not learned to plan breakfast, luncheon, or supper, will find this book a great help. It is highly recommended for home economics classes in high school.—E. Y.

The Glorious Art of Home Cooking; How to Plan, Prepare, Serve with Recipes for Every Need. By Hannah Dutaud. Chicago, Associated Authors, c1935. 282 pp., illus. Price, $2.75.

A homemaker who is interested in peace and happiness in the home will find valuable help in this book. The peace of a family is greatly influenced by the food served to it, and malnutrition is known to be responsible for many unhappy homes. This book helps the homemaker become skillful and efficient in the preparation of foods; it aids her in the preparation of a well-balanced meal, which means the judicious selection of materials, the right combination of foods, and intelligent cooking. It gives detailed instruction in homemaking and housekeeping. Meal planning includes instruction in table service. The different foodstuffs with their tested recipes are classified and well explained, making the book very handy for reference.

This book will certainly make "A home a place of retreat where we journey not merely to be housed and fed but to be nourished and strengthened."—C. A.

The Identity Theory. By Blamey Stevens. 2d Edition, revised and amplified. New York, G. E. Stechert and Co., 1936. 243 pp. Price, ₱4.

Here is a book on the identity theory—the theory that all mathematical expressions of the laws of nature are really identities because they simply equate different measures of identically the same thing. The book is divided into twenty-two chapters, and each chapter into articles each presenting a single deductive or inductive argument. A number of definitions and principles are given first as scaffolding for the development of the theory. Then the theory is proved by the inductive method. Numerous mathematical expressions of fundamental laws of physics are shown to correspond with one of the above three classes of identity. Much depends on ingenuity in proving that an expression is an identity, much similar to finding the integral of an expression.

The book is hard reading. To obtain a full grasp of the theory discussed one must be well acquainted with mathematical physics, both classical and modern. A general reader, however,

can obtain an idea of the character of the theory from the first three chapters and the introductions at the beginning of every chapter, without going into all the mathematics.—T. P. A.

The Medical Dictator; and Other Biographical Studies. By Major Greenwood. London, Williams and Norgate Ltd., 1936. 213 pp. Price, 7s 6d.

"That biographical sketches of men whose life work was technical, might still be readable" is the hope in which this book was written. It consists of biographical studies of seven medical men: Galen, John Friend, "Heart" Latham, William Farr, Louis, Osler, and Bacot. In a most vivid presentation of the lives of these men, the author has successfully produced an interesting book to be read not only by the medical man but also by the layman who wants to know these remarkable contributors to medical science.—M. B.

Medicolegal Cases; Abstracts of Court Decisions of Medicolegal Interest, 1931–1935. Compiled by the Bureau of Legal Medicines and Legislation, American Medical Association, Chicago, 1936. 888 pp. Price, $5.50.

This book represents an improved authoritative publication edited by the Bureau of Legal Medicine and Legislation of the American Medical Association, second to the initial volume previously published by the same Bureau as an experiment. It is a well-edited and arranged compilation, in an abstract form, of the most important court decisions of medicolegal interest, published in the journal of the American Medical Association during the calendar years 1931–1935, inclusive.

These decisions cover a wide range of civil, criminal, and administrative court cases within the broad medicolegal field and are therefore particularly important to physicians, lawyers, claim agents, government officers connected with accident and workmen's compensation, and the like. In fact, the comprehensive presentation in this book of the juridical, moral, sociological, and philosophical aspects of the professional relations of physicians to their patients, the society, the State and to each other, will be found increasingly valuable as a source of ready reference for the due understanding of the physician's rights, duties, and responsibilities in law. As has been rightly stated by the publishers in the Preface, "The idea prompting the publication of these abstracts in The Journal and in book form is not to qualify physicians to assume the rôle of counsel for themselves or for others, but rather to aid them in avoiding some of the legal and medical pitfalls into which their fellow physicians have fallen

and to exemplify the medicolegal problems that have been before the courts, so that physicians may more intelligently meet such problems when they arise."

Physicians, lawyers, and others interested in avoiding legal difficulties and in solving medicolegal problems when they arise, will find this book a useful addition to their reference libraries. —S. A.

Modern Criminal Investigation. By Harry Söderman and John J. O'Connell. New York, Funk and Wagnalls Co., 1936. 461 pp. Price, $3.

The book describes dramatically the murderous characters of the underworld and the scientific technic of modern detectives in solving crimes of baffling nature. It shows the versatility of the agents of the law in following the tracks of criminals and, with scientific devices, being able to turn to advantage most trivial clues found in and within the vicinity of places of crime. Famous crimes of international notoriety have been reënacted, showing how they were solved with scientific technic. Finger prints and pictures as valuable aids in detection are covered in one chapter. These and many other interesting aspects of detection are fully discussed step by step, such as the description and differentiation of arms and tools used in crimes and their identification, identification of individuals, investigations of robbery, arson, sabotage, forgeries, and the police laboratory. In fact, this book covers practically every phase of police science, and should be a good text for colleges and schools for detectives and policemen. Sociologists and journalists will find the book instructive and delightful reading. The authors deserve high commendation for writing such an authoritative book on a difficult and delicate subject.—M. P. R.

Practical Dietetics: With Reference to Diet in Health and Disease. By Alida Frances Pattee. 20th edition, rewritten and reset. Mount Vernon, N. Y., A. F. Pattee, 1935. 868 pp. Price, $3.

This book, written by a well-known dietitian in the United States, is an authoritative discussion of practical dietetics with reference to diet in health and disease. The book is divided into three parts. Part I deals with principles of nutrition. The functions of food, the processes of nutrition, and the values and requirements of food are thoroughly discussed in conformity with the newer knowledge of the subject.

Diet in therapy is given in Part II, covering normal and basic hospital diets, diet in disease and in special conditions. It includes the most widely used diets of eminent physicians. Em-

phasis is laid on the fact that the diet in sickness is merely the diet in health modified to meet certain abnormal conditions.

The third part is the most interesting of the book, as it covers the practical application of the principles of nutrition, showing how the diet for both the well and the sick may be prepared. It would be very useful to dietitians especially.

The last part of the book furnishes tables on food values, different foods supplying the different food elements and weight-height-age tables which would facilitate computations on the part of professional workers.—E. Y.

Rayon and Synthetic Yarn Handbook; a Practical Reference Book for the Producer, Manufacturer, Processor, Distributor, Drycleaner, Launderer, Economist, and Student. By E. W. K. Schwarz and Herbert R. Mauersberger. 2d enlarged edition. New York, Rayon Publishing Corporation, 1936. 558 pp., 230 illus., tables, charts. Price, $3.75.

There are various interesting aspects of the book dealing with the manufacture, treatment, and identification of artificial silk—rayon. The historical background of the different processes used in the rayon industry is especially of interest to student beginners, and good reading for the average layman. The technical processes of selecting, preparing, and successive conversion of the raw materials into a rayon filament or artificial silk thread are described in a brief and simple manner.

The chapter on raw materials should prove important to alpha cellulose manufacturers as a valuable guide in the selection of suitable fibrous plants. It not only deals with possible materials but also gives a definite time of the year when they are to be gathered with maximum yield. Proper preparation and seasoning are also described in full detail.

Spinning, dyeing, weaving, and the manufacture of knit goods are technically treated in such a way that any one without technical training can understand them. The chapters on cleaning and laundering are also of practical value as they contain suggestions, precautions, and formulas to be followed in washing the goods, in order to lengthen the life of the cloth, make washing easier, and preserve quality and luster.

The illustrations of the various threads of synthetic fibers facilitate their identification. Chemical and microscopical technic of differentiating one fiber from the other are briefly described. The chapter on physical testing particularly offer a good guide in the selection of material for any specific purpose. The subtitle of this work indicates for whom the book is intended and it is recommended to them.—M. P. R.

The Great Soil Groups of the World and Their Development. By Dr. K. D. Glinka. Translated from the German by C. F. Marbut. Ann Arbor, Michigan, Edwards Brothers, Inc., 1935. 150 pp. Price, $3.

This book, an important contribution to soil science in general, is the embodiment of the Russian school of soil science. The geographic position of Russia is ideal for the systematic study of soils. As one moves from north to south over the vast plains of European Russia, the fairly homogeneous character of the topography with gradually changing climatic conditions as expressed by moisture and temperature is observed. This feature of the country made it imperative for the soil scientists in the field to study the soil in all its aspects.

The author has defined the soil clearly, and out of this definition evolved a system of classification. Several systems of classification by different authors are mentioned. The classification here presented and discussed by the author recognizes the climate, particularly moisture as the most important factor in the recognition of the several soil groups. The two groups under this classification are the so-called "Ectodynamomorphic" soils and "Endodynamomorphic" soils. The "Ectodynamomorphic" soils include soils developed under (*a*) optimum moisture conditions, (*b*) average moisture conditions, (*c*) moderate moisture conditions, (*d*) insufficient moisture conditions, (*e*) excessive moisture conditions, and (*f*) temporary moisture conditions. The "Endodynamomorphic" soils include the Rendzina and the various skeleton soils.

A comprehensive discussion of the various soils in the different groups covers almost the whole part of the book. To students of soil science whose work deals mainly with soil classification, this book is highly recommended. A wealth of reference is cited after the discussion of each subject matter.—D. Z. R.

Illustrated Guide to the Fish Gallery, British Museum (Natural History). By J. R. Norman. London, The Trustees of the British Museum, 1937. 175 pp., illus. Price, 1s 6d.

This booklet gives the reorganization of the exhibition of the Fish Gallery of the British Museum (Natural History). The first part deals with a general survey of the gallery, particularly with the fishes shown in the classificatory series. The second part, the major part of the guide, is devoted to the special exhibits of the arrangement of the Fish Gallery and the fishes on display, and should be most helpful to the curators of museums.

The accumulation of information on the fishes in the special exhibits is especially interesting and instructive to teachers and students of natural history and biology, as well as to sportsmen. The booklet is paper bound with six plates, one colored, and one hundred text illustrations. The index makes it a convenient reference work.—D. V. V.

The Vaccination Problem. By Joseph P. Swan. London, C. W. Daniel co., Ltd., 1936. 320 pp. Price, 5s.

This book may be regarded as an appeal for the abolition of all laws enforcing or encouraging vaccination against smallpox. It is a work in which the antivaccinationists can find solace, in the detailed exposition of perhaps all arguments against vaccination that satisfy the most discriminatory antivaccination taste.

It deals extensively with the history of the antismallpox vaccination movement, the fights and struggles which the antivaccinationists had to endure at the beginning, the origin and development of the antivaccination movement in England until the conscientious clause was included in the laws of England. It relates in detail the creation, work, accomplishments, and conclusions of the Royal Commission which conducted the inquiry regarding vaccination during the period of 1889–1896.

This book, although apparently an unbiased exposition of anti- and provaccinationist opinions, is in reality a passionate argumentation against vaccination. It describes the apparently contradictory opinions regarding the protection conferred by vaccination which at the time of the discovery was considered to confer absolute immunity, and does not consider the different conditions influencing vaccination in such a way that the duration of the immunity so conferred varies according to individual and other factors. It is firm in the belief of the duality of smallpox and vaccination. In its discussion of Dr. Wanklyn's book on the Administrative Control of Smallpox, it emphasizes the assertion that of the seventeen steps to be taken when smallpox break out that are included in the list only 3 relate to vaccination and consequently, after, the other 14 steps are observed, there will be no need to waste time and money on the remaining 3 on vaccination.

The author's review of the League of Nations Health reports contains unfavorable comments on what are believed vulnerable points. It is a book that will evidently be received with a cheer welcome among the antivaccinationists.—G. I.

Henley's Twentieth Century Book of Formulas, Processes and Trade Secrets. Edited by Gardner D. Hiscox. 1937 Revised and enlarged edition by Prof. T. O'Conor Sloane. New York, The Norman W. Henley Publishing co., 1937. 883 pp. Price, $4.

This 1937 revised and enlarged edition contains ten thousand selected household, workshop, and scientific formulas, trade secrets, and chemical recipes and processes. The editors "have endeavored to meet the practical requirements of the artisan, the housewife, and the general home worker." Several formulas for making adhesives, beverages, bleaches, concrete, essences and extracts, hair preparations, inks, insecticides, lacquers, shoe polishes, soaps, wood preservatives are given. Those interested in the field of manufacturing pharmacy and related industries will find the volume a useful source of information regarding recipes for creams, lotions, lipsticks, manicures, and other beauty preparations. Interesting information about chromium plating (Fink's Process) is also available from this work. The section dealing with new discoveries in photography offers valuable data to photographers, both professional and amateur. For the convenience of those who desire to have a ready reference to sources of supplies and materials needed in various formulas included in the volume, a classified buyers' guide giving the names and addresses of dealers handling such articles is given in a section of the book.—P. V.

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